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THE INVENTOR.

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AT this year's exhibition of the Society of Artists, in Paris, the picture by M. V. Guetin, entitled "The Inventor," attracted considerable attention on account of its marvelous execution. The inventor is shown at work in his laboratory. This offers an admirable excuse for painting the innumerable tools and pieces of apparatus which the inventor finds necessary in carrying on his investigations. For our engraving we are indebted to La Ilustracion Española y Americana.

GLASS OF THE FIFTEENTH, SIXTEENTH, AND SEVENTEENTH CENTURIES.

FOREMOST stands Venice, which, at the beginning of the thirteenth century, obtained workmen from Constantinople, and founded workshops that were in full activity till 1291, when they were all transferred to the neighboring island of Murano. During the fourteenth century the principal manufacture consisted of beads, imitation jewels, etc., which found a ready market in Asia and Africa. In the fifteenth century an impetus was given to the manufacture, arising from the capture of Constantinople by the Turks and the revival of ancient art in Italy; the former throwing the glass trade almost entirely into the hands of the Venetians, while the latter furnished the artist with fresh and valuable sources of design. It was not, however, until early in the sixteenth century that the very beautiful process of which so many and such exquisite varieties are to be met with in private and public collections was discovered—a discovery which at first was religiously kept secret by the manufacturers themselves, and against the divulgence of which the Venetian government passed most stringent orders and threatened the severest penalties; while, on the other hand, the glassmakers who remained faithful and silent, content with Murano, were made citizens of Venice on that account alone, the highest official positions being open to them; indeed, such singular honor was paid to them, that masters of the art were looked upon as little inferior in dignity to the highest nobles, and special and peculiar privileges were extended to them.

During the whole of the sixteenth and seventeenth centuries Venice was the principal glass manufactory of all Europe, at which every conceivable variety for use and ornament was produced.

Early in the eighteenth century the Bohemian manufactures became noted, and the cut glass of that country caught Fashion's ever variable fancy. From that period the art gradually declined at Murano, and the privileges of the glassmakers were annulled. Then came the decay of the republic of Venice, and its destruction by the French at the close of the eighteenth century; since which time, although the manufacture of glass is still carried on at Murano, its glory has quite departed, and its principal trade again been reduced to beads and ornaments.

More even than for the exquisite beauty and delicacy of its contours and proportions, Venetian glass is celebrated for its ornamental patterns in latticinio, or milk-white threadwork, enamel, etc. The principal and most characteristic varieties of the manufacture were:

1. Subjects in white or stained glass, ornamented with enamel colors and gilding.

2. Glass ornamented with latticinio, or small milk-white threads, which, either milk-white or otherwise colored, are inclosed in the glass. These are spirally twisted into a charming variety of patterns.

3. Pieces in which two sheets of thin glass are conjoined, so as to form a network of latticinio or other colored threads, between each mesh of which a small air bubble is formed. The extreme delicacy, exactness, and minuteness of these pieces have defied all efforts at successful imitation. The variety was known as vitro di trina (lacework glass).

4. Mosaic glass, in which slices of colored threads or reeds were placed within two layers of white glass and fused into masses ready for forming vases, etc. This kind has been very successfully revived in the present century. It was termed millefiore or vitro florito (flowered glass).

5. Glass in which minute particles of gold are arranged in patterns and fused, or in which metallic filings were dropped in the process of fusion, so as to form patches or specks of gold, etc., called aventurine.

6. Dark mottled glass, of various colors, fused and blended, which, when held to the light, shows a deep ruby color. To this species the German word schmelze has been applied.

Other varieties were named schmelze aventurine, a combination of the last with the gold specks of the aventurine, frosted or crackle glass, and frosted glass with masks, flowers, etc., blown in relief on it from within.

These are some of the principal processes found in old Venetian glass, which, besides the elegance of its forms, already noticed, is remarkable for some most grotesque and curious designs in the shape of animals, fishes, nondescripts, etc., which are stated to have been chiefly in use for chemical purposes. Some of the foregoing processes have been imitated in other countries, but Venetian glass far surpasses them all in the beauty and variety of its outlines, and the fragility of its material, which was of so delicate a nature that it was believed, if poison were poured into certain of the finest specimens, the glass would break.

Germany, during the sixteenth and seventeenth centuries, manufactured a number of large glass goblets, ornamented with armorial bearings, figure subjects, foliage, and inscriptions in enamel colors, which afford much interest and information on contemporary events, which commemorate the purposes for which they were often specially made.

Engraving on glass, though commenced with the diamond point by the Venetians in the sixteenth century, was carried to greater perfection by machinery in Germany, France, and Holland, from the seventeenth century to the present time. Etching on glass by means of a powerful acid was also practiced in the seventeenth century, the discovery being attributed to Schwanhard, of Nuremberg, whose secret, however, died with him.

The first manufacture of glass established in England appears to have been in the year 1557, at the Savoy House, in the Strand. In 1635 a patent was granted to Sir Robert Mansell for glass making, but it could not have been on any large or important scale, as the same patent empowered him to import Venetian glass. In 1670 the second Duke of Buckingham induced some Venetian workmen to settle in London, but ornamental glass making never prospered, and it was not until the present century that the higher branches of decorative workmanship have been successfully practiced, and their application extended to a great and increasing variety of subjects.

It may be remarked that in the arts of glass making, pottery, and metal work, the East preceded and excelled the West in works of industrial art.—Pottery Gazette.

ON THE SALINE EFFLORESCENCE OF BRICKS.

THE MEANS OF AVOIDANCE.

By Dr. OSCAR GERLACH, Ph.D., Berlin.

MY subject is the avoidance of efflorescences, and for the sake of clearness I shall briefly recapitulate the modes of origin, taking up the means of avoidance in connection with each separately.

WHITE EFFLORESCENCES.

Sources.—I. The Green Clay.

1. Caused by the antecedent presence of sulphates in the clay.
2. Caused by the formation of sulphates during the storage of the clay.

Sources.—II. The Manufacturing.

1. During moulding.
   a. Caused by the presence of sulphates in the water or coloring matter.
   b. Caused by the formation of sulphates during drying.
2. During burning.
   a. Caused by the water-smoking.
   b. Caused during burning.

Sources.—III. Environment of the Bricks and Buildings.

1. Caused by the absorption of saline solutions from the soil of the place of storage.
2. Caused by the absorption of soluble salts from the soil on which the building stands.

YELLOW AND GREEN EFFLORESCENCES.

1. Organic in character—caused by the action of vegetable micro-organisms.
2. Inorganic in character—caused by soluble vanadiate salts.

Source I. The Green Clay.—The quantity of sulphates antecedently present in the clay is usually not very large, but 0·1 to 0·05 per cent. is quite sufficient to impart to the product an annoying white incrustation. To prevent this efflorescence, the soluble salts must be converted into insoluble by the addition of appropriate chemicals. The most effective and the most economical are the barium compounds, and particularly carbonate of barium and chloride of barium. Barium salts possess a strong affinity for sulphuric acid. When barium salts come into contact with sulphates an immediate transformation takes place, the sulphuric acid combining with the barytes to form sulphate of barium—a combination absolutely insoluble in water. Expressed in chemical formulæ, the transformation of the calcium sulphate with the barium compound above mentioned is as follows:

Sulphate of calcium.		Carbonate of barium.		Carbonate of calcium.		Sulphate of barium.
$CaSO_4$	+	$BaCO_3$	=	$CaCO_3$	+	$BaSO_4$
Sulphate of calcium.		Chloride of barium.		Chloride of calcium.		Sulphate of barium.
$CaSO_4$	+	$BaCl_2$	=	$CaCl_2$	+	$BaSO_4$

In both cases the sulphuric acid is transferred to compounds that are insoluble in water, and so is absolutely incapacitated from producing the injurious incrustations. If these salts are easily and cheaply had, it is indifferent which of them the manufacturer employs; but if they have to be brought from a distance, it is more economical to employ the chloride of barium. The reason of this is plain, from the chemical nature of the salts.

MODE OF EMPLOYING CARBONATE OF BARIUM.

We shall first take up the carbonate. Carbonate of barium is insoluble in water. To procure a uniform effect, therefore, the salt must be mixed with the clay very thoroughly and in as finely powdered a form as possible, because the transformation of the soluble sulphates takes place only where the two salts come into immediate contact with each other. The amount required is relatively very small. But since it is difficult to mix small quantities with the requisite thoroughness, a large excess of carbonate of barium should be employed, say from ten to twenty times the amount which is theoretically sufficient, in order to insure the conversion of all the soluble sulphates into insoluble salts of barium. The excess of carbonate of barium is not injurious, since it is absolutely insoluble in water.

I will now give examples of how the matter is to be carried out in practice.

First, the clay must be analyzed and the amount of sulphates in it determined. Analyses of the kind in question are best made in a special laboratory. Let us suppose the clay contains 0·1 per cent. of calcium sulphate ($CaSO_4$). One kilogramme of dry clay contains 1 gramme of calcium sulphate. One English pound contains 0·455 gramme. One gramme calcium sulphate requires, according to the formula, for perfect conversion into barium sulphate, 1·45 grammes of carbonate of barium. Hence, theoretically, for 1 kilogramme of clay, 1·45 grammes of barium carbonate, or for one English pound of clay, 0·66 gramme of barium carbonate must be used. Since, now, for the reasons stated above, ten times the amount theoretically required must be employed, therefore 6·6 grammes barium carbonate must be used for every pound of clay. Supposing the green brick weighs 7 pounds, then for one brick 46·2 grammes, or for a thousand bricks 46·2 kilogrammes, or 101·6 English pounds, would be required. A pound of barium carbonate costs 2½ cents. Therefore, for a thousand bricks an extra outlay of $2.50 would be necessary.

Much cheaper is the process if chloride of barium be employed, for here the transformation takes place instantly and more energetically. This salt is readily soluble in water, and in its dissolved condition is uniformly absorbed by the clay particles, so producing an immediate transformation of the soluble sulphates into insoluble. While the carbonate of barium must be used in considerable excess, in employing the chloride of barium it is advisable to keep as closely as possible to the theoretical limit, because too great an excess is quite apt to cause a recrystallization of the chloride of barium on the surface of the brick, and so to give rise to other incrustations.

THE EMPLOYMENT OF CHLORIDE OF BARIUM.

We use the same clay as before, namely, a clay containing 0·1 per cent. sulphate of calcium. One gramme of calcium sulphate requires theoretically 1·8 grammes of crystallized chloride of barium ($BaCl_2+2H_2O$). One kilogramme of clay containing 0·1 per cent. sulphate of calcium requires, therefore, 1·8 grammes chloride of barium, one English pound requires 0·82 gramme chloride of barium.

Supposing, now, the green brick weighs seven English pounds, then one brick would take 5·74 grammes and a thousand bricks would take 5·74 kilogrammes barium chloride. If barium chloride costs 2½ cents a pound, a thousand bricks, therefore, would require an extra outlay of only 32 cents.

In using barium chloride, chloride of calcium is produced as a collateral product; but this has no injurious effect, since it is readily decomposed at red heat into oxide of calcium, and as such acts as a flux.

In like manner, the coloring matter and the water used should be analyzed for their sulphur, and treated accordingly with barium chloride.

Source II. Manufacturing.—If the clay, treated as above indicated with chloride of barium, be used at once, no coloring will be noticeable either on the surface of the unburnt or on the surface of the burnt brick; but if the clay as thus treated be allowed to lie for any length of time, new quantities of iron pyrites will be converted under the influences of weathering into sulphates, and so fresh additions of the chloride will be necessary. If the clay has been made into green brick, the process of drying should be accomplished as quickly as possible, to prevent the subsequent accumulation of sulphates on the surface. On the other hand, quick drying prevents the deposition of possible other salts which are present, on the surface of the products. In general the deposition takes place here preferably in the interior.

It has often been observed that bricks manufactured from sulphurous clays, which come absolutely uncolored from the kiln, afterward show distinct colorations. This is largely due to the drying. The evaporation of the water takes place in most part on the surface, and most energetically at the places which are most exposed to the draught. And so the incrustations are first and most commonly found on the edges of the product, while the spots where the bricks rest upon one another, and where, consequently, no evaporation can take place outwardly, are quite free from colorings. The more quickly the evaporation of the water is effected, the less will be the quantity of salts visible on the surface. This is explainable from the following consideration:

The water in the interior of the bricks must ascend through the fine pores to the outer surfaces. If the water ascends slowly through the pores, occasion is given for its saturating itself thoroughly with the soluble salts and so carrying them to the surface.

The phenomenon admits also of another explanation. As stated above, and owing to capillarity—that property in virtue of which fluids rise by attraction on the walls of minute tubes—the evaporation of the water takes place mostly on the outer surfaces of the bricks, which constitute a system of fine tubes. Now, it is a familiar fact of physical chemistry that very many saline solutions do not rise uniformly and unaltered through such systems, but that they are separated in such a process into pure water and a concentrated solution of the salt. The water hastens in advance of the salt—and the more quickly, according as the ascent is rapid, or according as the brick is more porous, or according as the evaporation of the water is accelerated at the surface. The pure water will thus first reach the surface and be evaporated there, while the saline solution will be kept back in the interior of the brick, where it will gradually be deposited if no more water is present to dissolve it; but if the progress of the water be slow, the saline solution will reach the surface with it and be deposited there.

The incrustations, therefore, which appear during drying are found more frequently on bricks which are made from oily (plastic) clays than on bricks made from relatively non-plastic or sandy clays. In the former the porous system is considerably restricted, the orifices are smaller, and the water has more obstacles to encounter in reaching the surface. In the latter, in bricks made from sandy clays, owing to the greater porosity, the evaporation takes place more energetically, and not only at the surface, but also partly in the interior: first, because the interstices are here much larger; and secondly, because the sand prevents the perfect closure of the pores. This is why the smooth surfaces of pressed brick show the saline efflorescences more than the rough surfaces. By the action of the press the lateral surfaces of the brick acquire a denser structure than the upper and under surfaces. And also in ejection from the press, owing to the friction between the plastic brick and the sides of the form, these same lateral surfaces are still more densely compressed. By this compression the escape of the water is obstructed; consequently, because of its evaporating slowly and gradually, the water carries all the dissolved saline components to the smooth surface, where they are more readily rendered visible than on the rough surface, where, owing to the magnitude of the porous orifices, a partial evaporation of the water, and therefore also a deposition of the salts, occur in the interior.

There is a kindred annoying phenomenon which makes its appearance principally on the rough surfaces of the bricks, when the impressions of the workingmen's hands become visible. Frequently, after burning, certain spots are found colored white, while the remainder of the brick exhibits the normal, desired color. These are the spots at which the brick has

been subjected to the pressure of the workingman's hand.

From what has gone before, an explanation for this readily suggests itself. By the pressure of the workman's hand, which is always more or less moist, the pores of the brick are closed at these spots, and the spots themselves made smooth. In consequence of the slower evaporation of the water here, the salts will be deposited at these places first, and the deposition will be rapidly augmented by the constant crystallization at these points of the saline water of the environment.

Another explanation is the following: During drying, salts come to the rough surface of the brick, but, owing to the roughness of the same, are not visible to the eye. If, now, by the pressure of the workingman's hand, these places are flattened, and the minute saline particles crushed, the white coloration will be much more noticeable at these spots than at the reminder of the surface. An illustration will explain my meaning.

Imagine a very large number of minute particles of chalk on a slate or blackboard, and about a millimeter apart from one another. The original color of the board will not be destroyed by the particles. A short distance away, the dark coloring of the board alone will be noticeable; but if we stroke the board lightly with our moist finger, the soft particles of chalk will be crushed and pressed into the granular surface, so obliterating the dark coloring, and rendering the white path of the finger distinctly visible.—The Brickbuilder.

ECONOMY TEST OF A UNIQUE FORM OF FEED PUMP.

By F. MERIAM WHEELER.*

DURING the past few years considerable attention has been given to the subject of steam economy of the auxiliary machinery on steam vessels, particularly those on warships, where a saving of coal has much to do with the steaming radius of the vessel. One of the most interesting papers on this subject was read by P. A. Engineer W. W. White, U. S. N., at the last meeting of the Society of Naval Engineers, and some remarkable figures were shown in regard to the test of the auxiliaries of the U. S. cruiser "Minneapolis"—from the dynamo engines down to the smallest steam pump. In taking part in the discussion of Mr. White's paper, I particularly referred to the economies of the different pumps used in this warship, which economies varied very much according to the speed and pressures the pumps were operated. Under favorable conditions, as, for instance, in the full power trials of the United States warships, it has been found that in the case of the main feed pumps the average indicated horse power developed by such pumps is about one-half of one per cent. of the I. H. P. of the main engines. I mention this fact to show that feed pumps use more power than any other pumps of a vessel. It will, therefore, be seen that the feed pump is quite an important auxiliary, and everything should be done to improve its economy in the use of steam. For this reason I have given considerable attention to the subject, and take pleasure in now bringing to the notice of the Society the "Economy test of a unique form of feed pump" recently conducted in England, in which the economy was quite remarkable compared with that of the ordinary type of steam pumps usually employed for feeding boilers.

Now, it has been shown by tests made, not only by Mr. White, but many others, that the steam consumption of a feed pump of the duplex type (the one most commonly in use in the vessels of the U. S. navy) will average about 120 pounds weight of steam per I. H. P. per hour. In the tests made on the "Minneapolis" the very best economy shown in the case of the main feed pumps was a little over 93 pounds, while the poorest showing (i. e., when one of the main feed pumps was supplying the donkey boiler, and consequently running at an abnormally low rate of speed) was over 200 pounds per I. H. P. per hour. The particular pump my paper refers to did its work with an expenditure of only 52 pounds of steam per I. H. P. per hour, which, considering the fact that it was quite a small unit, is a most excellent showing. In other words, this special form of pump uses considerably less than one-half the steam required ordinarily by a duplex pump of the simple type.

The test referred to was conducted by experts connected with the engineering department of the well known engine builders, Messrs. Willans & Robinson, at their works in Rugby, England, and was for the benefit of the British Admiralty, who were represented by Mr. Anstey, their fleet engineer. There were also present Mr. Keighly, representing Messrs. Thornycroft & Company, Mr. Krohn, representing Messrs. Yarrow & Company, and Mr. Hobbs, representing the Chester Engineering Company; also Mr. Powel, representing the Blake & Knowles Steam Pump Works, of London.

The feed pump tested consisted of a pair of Blake "Simplex" vertical double-acting steam pumps arranged on the cross-compound plan (see engraving of perspective view, Fig. 1), the high pressure side having

6" diameter steam cylinder,
3½" diameter water cylinder,
8" stroke,

and the low pressure side having

9" diameter steam cylinder,
3½" diameter water cylinder,
8" stroke.

As shown by the engraving, the steam was first used in the 6-inch cylinder, and then expanded into the 9-inch cylinder; from the latter the exhaust was condensed and carried to the weighing apparatus. Both water cylinders were connected to the one suction pipe having a length of 70 feet with five bends. The height of suction from level of the water in the supply well to the level of the discharge valves in the pump cylinders was 19 feet, to which should be added about 2 feet to represent the friction in the suction connections. The discharge of each pump led into a Y connection, as shown, and the discharge pipe was provided with a gate valve sufficiently throttled to put on the pump cylinders a pressure of about 200 pounds per square inch, which, by the way, will be about the pressure these pumps are to feed against when installed in the torpedo boat for which they were built.

I desire to call attention to an important feature of this arrangement of pumps in that it has all the advantages of the duplex system, so far as the continuous flow of the water is concerned, and yet either side can be run as a separate pump in case of accident to the other side. Then again, the economy of compounding is secured with but two steam cylinders instead of four, as would be the case of a compound duplex pump. Therefore, there is less loss of steam from cylinder condensation; clearance is also reduced to a minimum, as the valve gear of one pump is not operated by the opposite pump, as in the duplex system; consequently, one side can make a full and complete stroke without interference from the other side of pump.

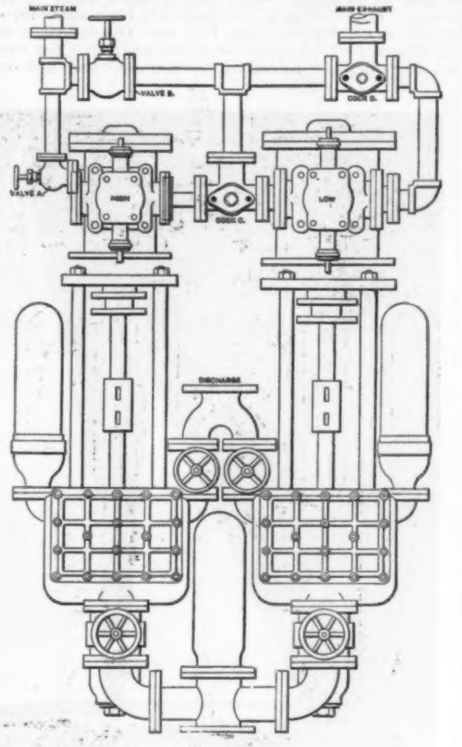


FIG. 6.

The arrangement for testing (excepting the naked pipe that supplied the steam) was as complete and perfect as could be desired. For condensing the steam a surface condenser was employed with tubes having only screwed joints (Wheeler double tube system), the same being tested to 200 pounds per square inch, so there was no suspicion of leakage. The condensed steam was carefully weighed in a perfectly balanced collecting tank. A small air pump was used simply for drawing off the water of condensation and discharging same to the weighing tanks, forming little or no vacuum. It was the intention of forming no vacuum in order to have this compound pump run under the usual conditions when exhausting into an auxiliary feed water heater—the latest and most economical method in use! The length of stroke could be accurately measured, as metal pointers were attached to the piston rod crossheads. The length of stroke was easily regulated, as one of the special features of the "Simplex" valve gear is the arrangement of the adjustable collars on the valve rods so that proper length of stroke can be obtained for all speeds, even when the pumps are in operation. The testing apparatus at Willans & Robinson's works is one of the most complete and perfectly arranged in Great Britain. The weighing of the water during the test was done automatically by electrically connected attachments, so that great accuracy was obtained, and the time observations were taken to a fraction of a second.

Two tests were made: First, by running the pump compound; and, second, by shutting off entirely the low pressure side and running the high pressure side as a simple pump. As mentioned above, the economy of the pumps when running compound was at the rate of 52 pounds weight of steam per I. H. P. per hour, while the economy of the pump running as a simple pump was at the rate of 93·41 pounds per I. H. P. per hour. The former test is designated as "A" and the latter as "B," of which the following are the particulars:

TEST "A."—COMPOUND.

Duration of test	20·55	minutes.
Speed per minute, each side	40	double strokes.
Average length of strokes	8·06	inches.
Initial steam pressure per square inch	112·5	pounds.
Mean steam pressure per square inch high pressure cylinder	58·06	pounds.
Mean steam pressure per square inch low pressure cylinder	30·28	pounds.
Power developed by high pressure cylinder	2·54	I. H. P.
" " low pressure cylinder	3·07	I. H. P.
Total power developed by both steam cylinders	5·61	I. H. P.
Total weight of water collected	100	pounds.
Weight of water collected per hour	292	pounds.
" " per I. H. P. per hour	52·04	pounds.

TEST "B."—SIMPLE.

Duration of test	28·35	minutes.
Speed per minute	54	double strokes.
Average length of stroke	8·05	inches.
Initial steam pressure per square inch	67·5	pounds.
Mean steam pressure per square inch	62·23	pounds.
Power developed	3·961	I. H. P.
Total weight of water collected	175	pounds.
Weight of water collected per hour	370	pounds.
" " per I. H. P. per hour	93·41	pounds.

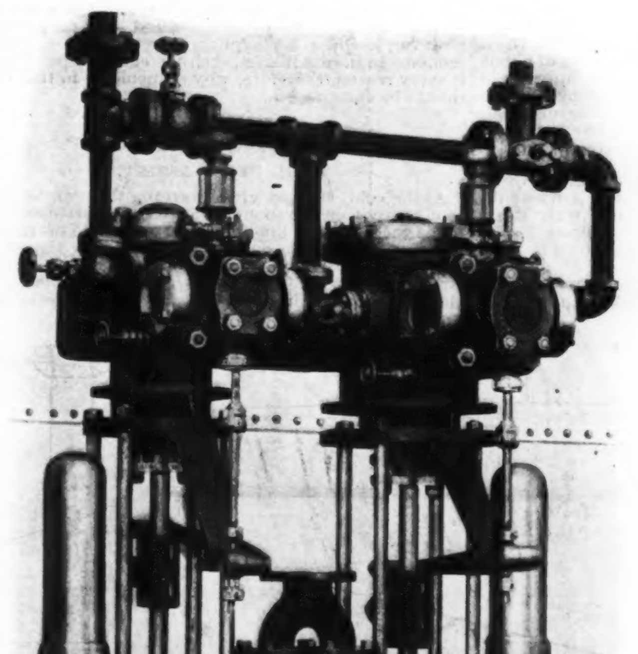


FIG. 1.

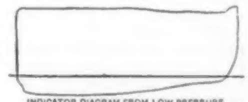
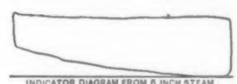
FIG. 2.

INDICATOR DIAGRAM FROM LOW PRESSURE STEAM CYLINDER, PUMP RUNNING COMPOUND. SCALE, 50 LBS.=1 INCH.

FIG. 3.

INDICATOR DIAGRAM FROM HIGH PRESSURE STEAM CYLINDER, PUMP RUNNING COMPOUND. SCALE, 120 LBS.=1 INCH.

FIG. 4.

INDICATOR DIAGRAM FROM 6 INCH STEAM CYLINDER, PUMP RUNNING SIMPLE. SCALE, 120 LBS.=1 INCH.

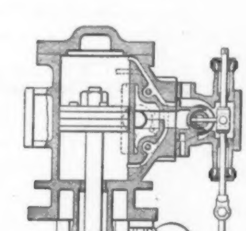


FIG. 5.

* Read at the sixth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, November 10 and 11, 1898.

It will be noticed that these tests were of short duration, but they were amply long to demonstrate the economy of the pumps under the conditions given. The so-called system of "Flying test," in the opinion of the writer, is one of the best when the testing apparatus is electrically operated.

Indicator diagrams, taken from the steam cylinders when running compound and simple, are herewith shown. Fig. 3 is the diagram from the high pressure cylinder and Fig. 2 the diagram from the low pressure cylinder when the pumps were running compound; Fig. 4 shows the diagram from the pump running "simple" (single pump).

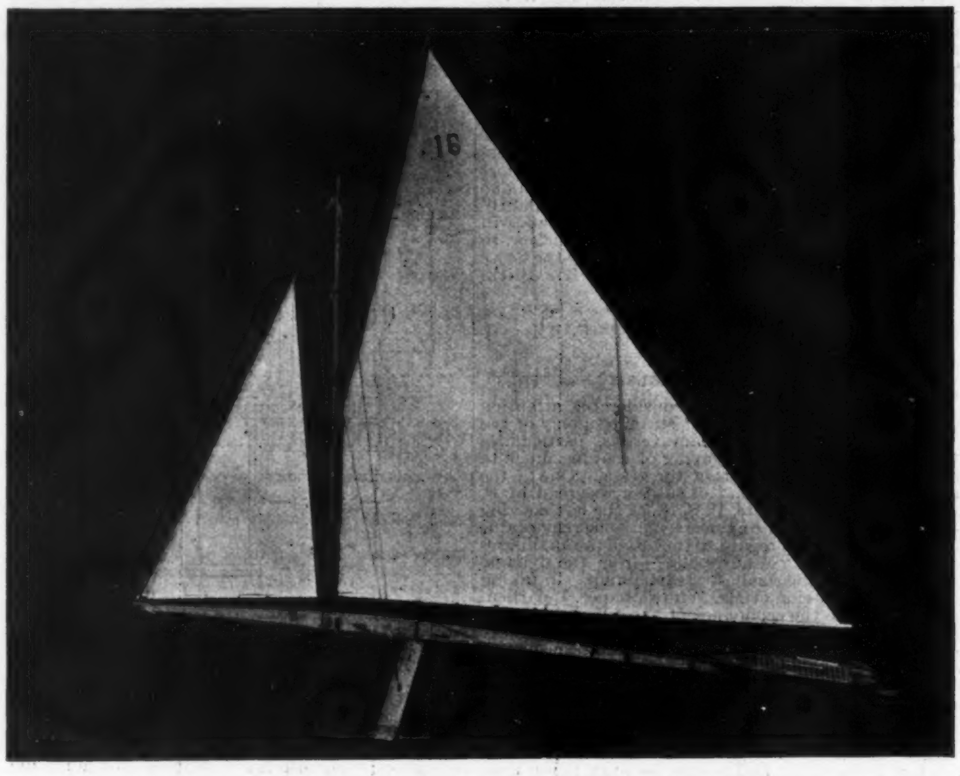
The steam valve mechanism is very simple, and is shown by the sectional view of the pump (see Fig. 5); it will be seen that the valve rod (so called) has no valve directly attached to it, as is usual; it merely rotates the auxiliary piston, which latter combines within itself the auxiliary valves. This rotating motion is a great advantage, as it frees the auxiliary piston from possibility of sticking for any reason, causing the pump not only to be positive in its action, but securing uniformity of wear. The rolling movement given this auxiliary piston by means of the "valve rod" and the intermediate swinging pin or tongue opens and closes the auxiliary ports, which, in turn, control the steam to operate the auxiliary piston, moving said piston back and forth across the main steam cylinder. The auxiliary piston, like the main piston, is packed with spring rings.

A plain D slide valve is attached to this auxiliary piston, which valve supplies steam to the main cylinder through the two sets of ports, i. e., the main steam ports and the starting ports. By this cross arrangement of steam chest and valves, the pump can work just as well vertically as horizontally. A drawing giving the general arrangement of the pump and the steam pipes is shown by Fig. 6, particular attention being called to the manner of opening and closing the globe valves and cocks on the steam and exhaust pipes, in order to operate the pumps conjointly as a compound machine or separately as simple pumps.

Let us consider the practical advantage of this unique form of feed pump. It not only represents minimum weight and space, but has the advantage of containing within itself, so to speak, an auxiliary or spare pump, as either side of the pump can be operated independently, as before mentioned, should occasion require. As regards the amount of steam that can be saved by this system, there is no doubt but what the pump will save its own weight in coal in 24 hours' steaming. As an illustration, this particular pair of pumps with the attachments shown weigh about half a ton, and handled during the test at the rate of 17,570 pounds of feed water per hour.

Now this amount of water would supply the boilers necessary to operate a marine engine of the triple expansion type of about 1,100 horse power. The power of the pump as noted in the compound test was 5·61 I. H. P., or about one-half of one per cent. of the power of the engine above given. On the basis of a saving of, say, 70 pounds weight of steam per I. H. P. per hour over and above what would be ordinarily used by a duplex pump of the simple type, it shows a total saving of steam (feed water) of about 393 pounds per hour, or, say, 50 pounds of coal per hour, on a basis of about 8 pounds of water per pound of coal, for the rate of boiler evaporation. This gives a total saving of 1,200 pounds of coal per 24 hours, which, it will be observed, is somewhat more than the weight of the pump, so that I am rather understating than overstating the case. Or, as compared with the single system of feed pump, the cross-compound "Simplex" would save its weight in coal in forty (40) hours. There is no doubt but what with larger size pumps, and with steam pipes covered, the economy of the "Simplex" compound would be even better than that shown in these tests.

Taking the case of a large transatlantic steamer developing 30,000 I. H. P., which I understand will be the engine power of the new White Star S. S. 'Oceanic" now building, the amount of coal that could be saved on a trip (say of 5½ days) would be about 77 tons by the use of a system of feed pumps of this cross-compound "Simplex" type, as compared with the duplex system; or, a saving of about 44 tons of coal as compared with the single system of feed pump. This saving in coal not only represents an expenditure of many dollars, but also considerable saving of space which could be made available for cargo or other purposes affording a revenue, thus not only saving money at one end but adding at the other end. Much has been done during the present decade to improve the economy of the steam engine, and some remarkable results have been secured, but very little, however, has been accomplished in the line of steam economy in the auxiliaries, such as steam pumps. There is every reason, therefore, why refinements in this line should be encouraged.



A MODEL ICE YACHT.—DESIGNED AND BUILT BY H. PERCY ASHLEY.

AN UP-TO-DATE ICE SLOOP.

By H. PERCY ASHLEY.

As the cold weather gives warning that winter will soon be upon us, the thoughts of all true sportsmen turn to ice yachting, the king of winter sports. This month all the ice yachts are overhauled and newly rigged, or entirely new boats are built, preparatory to a daring struggle on the frozen surface for the supremacy of their club or locality. It was only a few weeks ago that the writer had the pleasure of examining a set of runners built by Mr. Oliver Booth, at Poughkeepsie, N. Y., in 1790, which are still intact and well preserved.

They are, of course, very crude in form, but they show, nevertheless, the beginnings of the modern ice yacht of 1898. The questions of over-canvasing and center of sail balance have, I am glad to say, nearly disappeared. Before their solution the yachts were hard to sail and steer, and often got beyond the control of the skipper.

Plate B shows by scale the sheer and sail plan of an up-to-date ice yacht, carrying 528 square feet of canvas, divided as follows: mainsail, 413 square feet, and jib, 115 square feet; making a total of 528 square feet, which places her as a second class racing ice yacht, with a guaranteed speed of a mile a minute, under favorable circumstances.

The sails are cross cut, as shown in Plate B, and are made from No. 10 duck. The dimensions are as follows: mainsail hoist, 13 feet; gaff, 17 feet; boom, 26 feet; leech, 35 feet; diagonal from jaw of gaff to end of boom, 26 feet. The jib measures as follows: on stay, 23 feet; foot, 12 feet; hoist, 18½ feet; perpendicular from stay to end of jibboom, 10½ feet. The backbone is formed of one single piece of basswood, or selected pine, capped top and bottom with 1 inch cherry or mahogany. The dimensions are as follows: Over all, 43 feet by 14 inches by 5½ inches; tapering at ends to 6 inches by 4¾ inches. For fore and aft curve, see Plate B.

A very delicate question is the running and standing

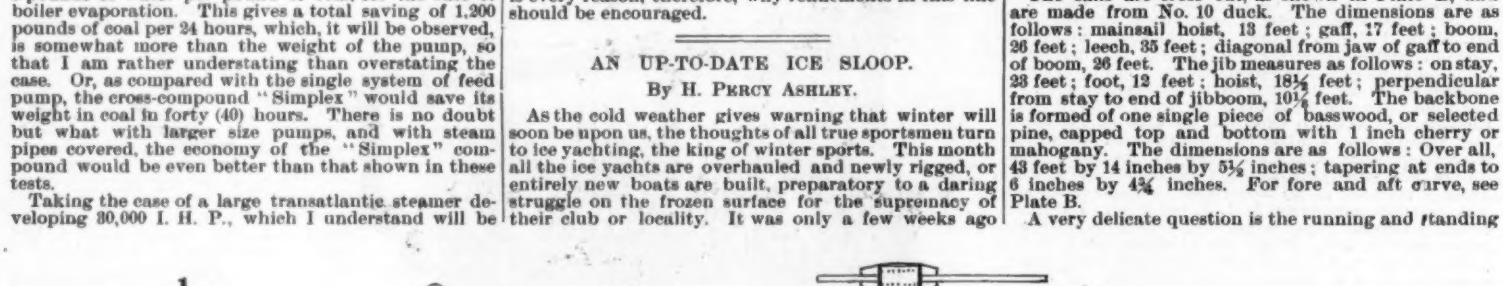
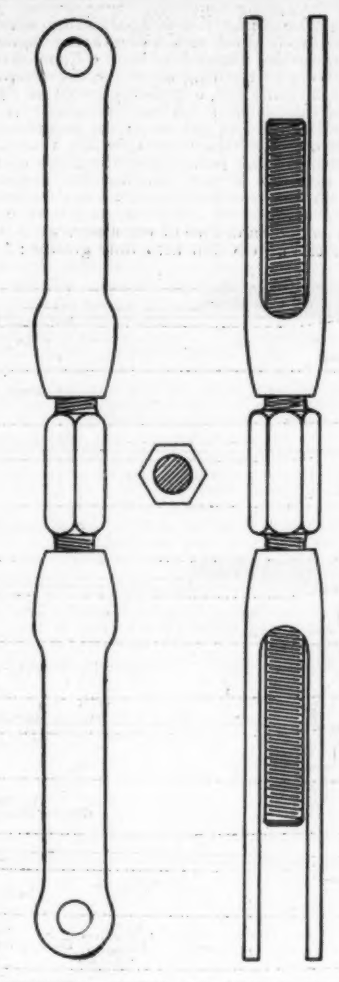


PLATE A.—DECK PLAN AND PARTS OF MODEL ICE YACHT.

rigging, which is rove and set up as follows: The shrouds are four in number, two being set up to port and two to starboard. There is a single turnbuckle on each side of runner plank at the distance marked in Plate A, No. 1. The upper shroud runs from the turnbuckle to the mast head and the other from the turnbuckle to the mast, where it ends just above the jaws of the gaff. The forestay starts in a loop at mast head and ends at the extreme end of the bowsprit. The martingale spreader is placed half way between the truck and the jaws. The martingale stay starts at the mast head, passes through the spreader, and ends at the backbone in a right and left turnbuckle and grip, just forward of the mast. This stay takes up the fore-and-aft strain on the mast. It was fully demonstrated last winter that the method of rigging the peak halyard employed by Com. H. C. Higginson, of Orange Lake I. Y. C., is the most practical one. This method is as follows: a two-part bridle of pliable wire rigging is set up at the gaff. From this is eased a whip or single peak halyard of heavy pliable rigging, which is passed through a metallic block at mast head (see Plate B) and led to backbone from mast head by a double block jig. This insures no give to the peak halyard in a blow or heavy ice. The old fashioned mast hoops have been discarded and in their place is set a patent mast hoist. The jib and main sheet have pliable wire rigging set up with jigs. The spars are all hollow, being served and parceled at stated intervals with light galvanized rigging.

The steering box is of a new design adopted by Com. Anderson, of Lake Pepin, Wis., I. Y. C., and used in the celebrated "Launa" and "Irene." A solid piece of oak 9¾ feet by 3⅛ feet forms the bottom (see Plate A, Fig. 2). This is surrounded by mahogany rails 4 inches high, bent to shape. It is fastened to the end of the backbone by bow shaped pieces of hickory and iron braces running from the under side of the steering box to the rails (see Plate A, Fig. 7), which hold it firmly in place when coming about. The flooring of the steering box is cut out and laced with light braided linen rigging, thus giving spring and ease to the helmsman over uneven ice. In Plate A, Fig. 3, is shown the midship section of the spreader on the backbone; in Fig. 4, the iron grip on the runner plank for holding bowsprit shrouds and runner backstay, which are one continuous piece, and are tautened by a single turnbuckle just aft of the runner plank. Fig. 5 shows the shape and size of the fore runners by scale.

Fig. 6 is a transverse section of the fore runners in position, showing steel angle plates which hold them in place. It is to be noted that these angle plates (Figs. 5 and 6) have taken the place of last season's oak guides and braces. They are fastened to the runner plank by bolts which penetrate the plank and the steel face plate on top. The runners are pivoted between the angle plates as shown (see Fig. 6). Following are the dimensions of the hull, as given in standard ice yacht tables: Length of center timber from rudder post to jib stay, 43 feet; length of center timber from rudder post to center of runner plank, 25 feet; cutting surface between runners, 22 feet; length of fore runners over all, 6¾ feet; height, including shoe, 8¾ inches; length of rudder runner, 4¼ feet. The dimensions of the runner board, which is made either of basswood or of butternut, is 22¾ feet by 14 inches by 5¾ inches at center and tapering to 2⅛ at the ends. For full description as to wood and construction of runners, with working draughts, see SCIENTIFIC AMERICAN SUPPLEMENT of February 12, 1898, No. 1154.



IMPROVED FORM OF TURNBUCKLE.

UTILITY OF MUSIC IN WAR.

"WHAT do you think of music?" was once asked of an eminent American novelist. "Oh," he replied, "I see no harm in it." This, Mr. Henry T. Finck thinks, illustrates the attitude of many people who consider music but a sort of plaything, and who will be surprised to learn in how many different ways music is and always has been useful to mankind. Mr. Finck thereupon proceeds (The Forum, May) to enlighten such Philistines. He refers briefly to the number of people who find a living in musical art and in the manufactures growing out of it (nearly 250,000, he thinks, in the United States alone); quotes from travelers to show how helpful music is to workmen in different countries both as stimulus and in insuring by its rhythm concert of action in such occupations as rowing; speaks of the various uses from time immemorial in religion, in medical practice (especially with nervous difficulties and in stimulating the brain), and in social life; and ranks it among the moral agencies because of its refining effects and its power to wean young people from debasing pursuits.

The utility of music in matters pertaining to war is also brought out strongly, and to this feature of the case we confine our quotations. The use of music in war signals is first touched upon:

"To the present day, in all the armies of the world, such musical war signals are considered not only useful, but absolutely indispensable. The infantry drill regulations of the United States army give the music and significance of more than sixty trumpet signals—calls of warning, of assembly, of alarm, of service, with such names as 'guard mounting,' 'drill,' 'stable,' 'to arms,' 'fire,' 'retreat,' 'church,' 'fatigue,' 'attention,' 'forward,' 'halt,' 'quick time,' 'double time,' 'charge,' 'lie down,' 'rise,' etc., besides a dozen or more drum-and-fife signals, all of which must be known to the soldiers, to whom they are a definite language, in the sense of Wagnerian Leit-motiv. Every one is familiar with such expressions as 'drumming up recruits,' 'drumming out deserters,' and so on."

But besides its use for signaling, music is used in five other ways for purposes of war: as a valuable adjunct in drill and parade, as (formerly) a means of producing

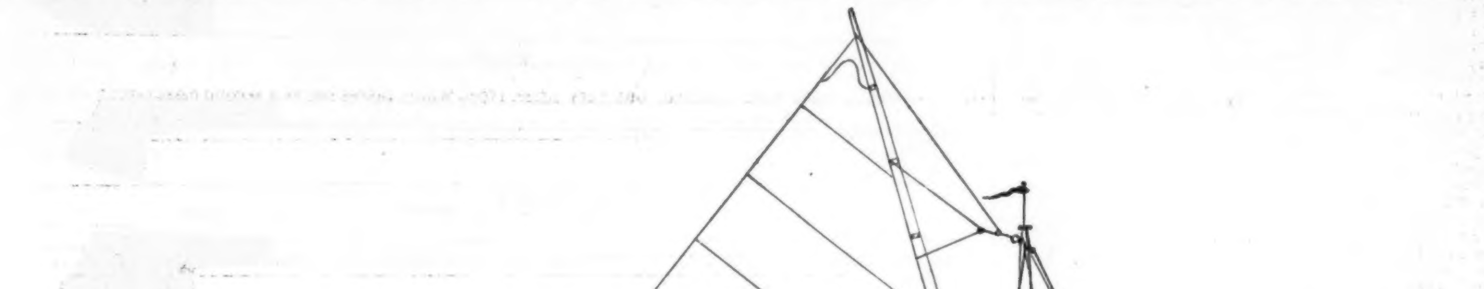


PLATE B.—SHEER AND SAIL PLAN.

panics, in arousing patriotism and keeping up courage, in inspiring soldiers in time of fatigue, and in providing entertainment in time of peace. In reference to its use in arousing warriors, Mr. Finck says:

"This use [in producing panics à la the Chinese] of music is obsolete in our armies. Not so the employment of melodies to rouse the courage of the soldiers and stir their flagging energies. Grey says that in Australia four or five old women can, with their singing, stir up forty or fifty men to commit any bloody deed; and Wallaschek justly says of primitive music that, instead of softening manners, it too often 'inspired the savages with a desire for fighting, it aroused their anger, excited their fanaticism, and, by accompanying their war dances also in time of peace, it aroused their lust for war.' For this reason it is among warlike nations that early music is most developed. The Spartans, the most warlike of all the Greeks, were remarkable for their devotion to music. Tyrtæus, seven centuries before Christ, induced them to use the martial trumpet; and his ardent patriotic songs helped the Spartans to many of their victories. In the Bible there are frequent references to the encouragement given to warriors by music, as for instance in 'Chronicles,' where the victory over Jeroboam is attributed to the encouragement derived from the sounding of the trumpet by the priests. It would be superfluous to add anything regarding the miracles of patriotic or fanatic valor wrought by such modern tunes as the 'Marseillaise' or 'Die Wacht am Rhein.'"

In the matter of dispelling weariness on the march, Field Marshal Lord Wolseley is quoted (in his preface to "The Soldier's Song Book") as follows:

"Troops that sing as they march will not only reach their destination more quickly and in better fighting condition than those who march in silence, but inspired by the music and words of national songs, will feel that self-confidence which is the mother of victory."

Mr. Finck adds:

"The German army includes more than 10,000 military musicians, able-bodied men who might as well be soldiers. We may feel sure that the great and shrewd commanders of the German army would not employ in times of war such an enormous number of musicians unless they believed that in this way these players could do more good than an equal number of fighting men. In other words, the generals fully appreciate and indorse the utility of music."

STABILITY OF A BATTLESHIP UNDER DAMAGED CONDITIONS.

By Prof. C. H. PEABODY.*

A PAPER presented at the meeting of this society in 1896, by Mr. James Swan, gives the account of an experimental investigation of the stability of a ship in damaged condition, by the aid of a wooden model, according to a method proposed by Mon. E. Bertin.† Mr. Swan's paper gives a sufficient account of the apparatus and methods employed for this purpose at the Massachusetts Institute of Technology. This paper will give the results of the application of the same methods and apparatus to a recent battleship. The experimental works and calculations required for obtaining the results were by Messrs. Curtis and Daniel, of the class of 1897, and by Messrs. Hervines and Kimball, of the class of 1898.

The principal dimensions of the ship are:

Length between perpendiculars	368	feet.
Beam	72	"
Normal draught	23½	"
Height of main deck above normal water line	11	"

The ship under consideration has a thick armor belt extending from the aft turret to the stern, the thickness being reduced toward the bow. A transverse armored bulkhead connects the after ends of the belt to the turret foundation, and another armored bulkhead extends across the ship just forward of the boiler rooms. Between the bulkheads there is a flat armored deck on top of the armor belt, and outside of the bulkheads at both bow and stern are armored protective decks with sloping sides. The armor belt, the armored bulkheads, and the armored decks serve to protect the buoyancy and stability of the ship as well as to guard the propelling machinery and magazines. Above the thick armor belt thinner side armor is carried up to the main deck for a space extending from turret to turret, and is joined to the turrets at the ends by transverse bulkheads. This armor affords additional protection to the buoyancy and stability, as do also cofferdams filled with cellulose.

Our investigations were intended to show the effect of such injuries as would admit water to the compartments on the protective deck outside of the armored transverse bulkheads, and also the effect of flooding certain of the compartments below the armored and protective decks. For this purpose an accurate wooden model was made on the scale of one-fourth of an inch to the foot. The model was made in two parts, one representing the lower body of the ship, up to the armored and protective decks, and the other representing the upper body between the main deck and the armored and protective decks. Disks to represent the turret foundations were cut out and fixed to the model of the lower body. The superstructure above the main deck was omitted from the model, as it was considered safer to neglect the additional stability that could be attributed to that part of the ship. The lower body of the model was divided longitudinally over the keel to facilitate the removal of parts representing compartments at one side only.

The model, with the inclining apparatus in place, was ballasted so that it floated at the proper water line, and so that it had the proper metacentric height. Then blocks representing the parts which were supposed to be laid open to the sea were cut out and lead weights were fastened to compensate for the wood removed. The initial inclination for a given condition was then determined, and also the change of time as well as the new water line. Then inclining experiments were made to determine the initial stability and also the stability at various angles of heel.

* Read at the sixth general meeting of the Society of Naval Architects and Marine Engineers, held in New York, November 10 and 11, 1898.

† Use of small models for determination of curves of stability. Trans. Soc. N. A. and M. E. Vol. II., p. 57.

Figs. 1 to 12 represent the compartments which are supposed to be injured, and indicate the changes of immersion and the changes of trim. Figs. 1a to 12a give the curves of righting arms for the several conditions 1 to 12, while Fig. 0 gives the curve of righting arms for the ship when intact as determined by calculation from the lines of the ship; the points near the curve were obtained from tests on the model. The correspondence of the points with the curve up to the maximum stability is very satisfactory; beyond the maximum stability the tests consisted in determining a condition of unstable equilibrium, and were not susceptible of so good a degree of certainty.

The tests can be divided into four groups: 1, those of compartments above the protective decks broken open; 2, those with bow compartments below the deck broken open; 3, combinations of 1 and 2; and 4, those with midship compartments broken open.

Figs. 1 and 1a represent the effect of breaking open all the aft compartments above the protective deck; the changes of immersion and of trim and the loss of stability cannot be considered to be important.

Figs. 2 and 2a represent the effect of breaking open all the forward compartments above the protective deck, and beyond the transverse bulkhead at the boiler rooms. This condition, which is much less likely than the first condition, is more serious.

The effects of opening to the sea all the compartments above the protective decks, both forward and aft, are shown by Figs. 3 and 3a. The changes of immersion and of trim are not important, but the loss of stability though not dangerous is important; but so thorough a destruction of the upper works of the ship may be considered to be very unlikely, if not impossible.

Figs. 4, 5, and 6 and 4a, 5a, and 6a represent the effects of breaking open bow compartments below the protective deck. Fig. 4 represents the injury as extending only to the first or collision bulkhead, and Figs. 5 and 6 represent it as extending to the second and the third bulkheads. The effect on stability is insignificant; in fact, the injury to the first compartment only gives a slight increase in stability. The combined effects of the changes of immersion and trim are serious, especially for the sixth condition, which shows the whole thick armor belt immersed.

Figs. 7, 8, and 9 and 7a, 8a, and 9a show the effects of breaking open at the same time all the forward compartments above the protective deck, and also of the first bow compartment, the first two and the first three compartment. The results of such injuries are shown in a most notable manner by the change of immersion and of trim. The ninth condition, with all three compartments below the protective deck and all the compartments above that deck, would probably make the ship unmanageable. The loss of stability is serious, but not necessarily dangerous. These tests show the wisdom of carrying the armor belt forward to the stem, and there provid-

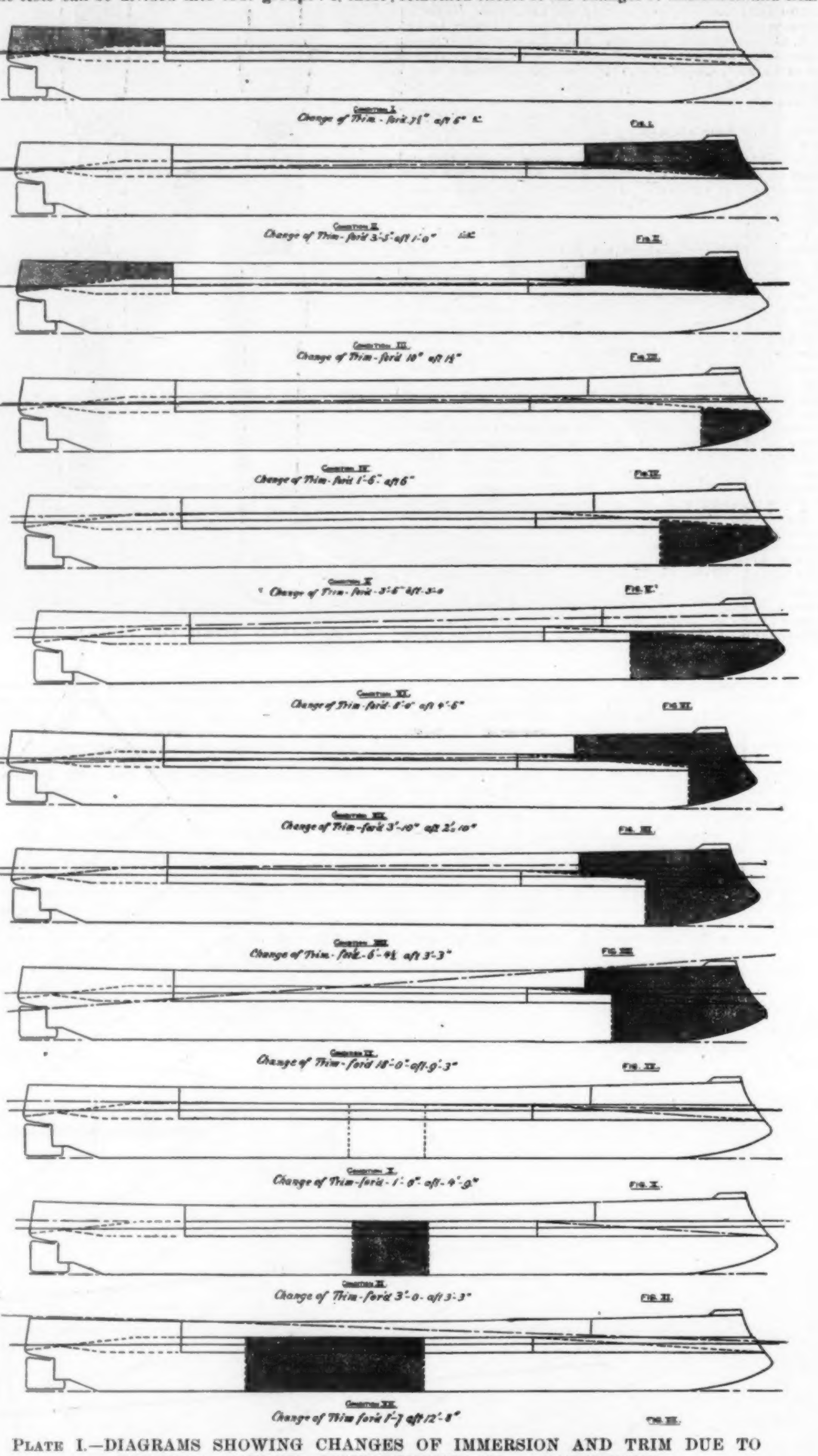


PLATE I.—DIAGRAMS SHOWING CHANGES OF IMMERSION AND TRIM DUE TO FLOODING VARIOUS COMPARTMENTS IN A BATTLESHIP.

ing against so serious damage. It is proper to remark that a corresponding injury at the stern would have a much less disastrous effect.

Figs. 10 and 10*a* show the effect of flooding the aft port boiler room. The ship trimmed down by the stern and took a list of 15° 20′. The loss of stability was serious, if not dangerous. This dangerous loss of stability could be remedied by the simple expedient of flooding the corresponding starboard boiler room, as is proved by Figs. 11 and 11*a*, representing the effect of flooding both boiler rooms. In that condition the ship remains erect with a sufficient amount of stability, and settles bodily till the immersion is to the top of the armor belt.

Figs. 12 and 12*a* show the effect of flooding the two after boiler rooms and both engine rooms. This caused the stern to sink till the main deck was immersed aft, and left only a trivial initial stability, which disappeared at an inclination of a little more than 15°. The only wonder is that so serious an injury should leave the ship afloat.

When one boiler room and one engine room on the same side were flooded, the ship capsized, and she sank when all the boiler and engine rooms were flooded. In the last case the whole mid-body of the ship was removed.

In closing, it is proper to say that extreme conditions were shown to develop dangerous effects. The fact that so extensive injuries are unlikely shows that the designer provided against all probable conditions, except the effects of large submarine mines.

EARLY MARINE ENGINEERING IN THE UNITED STATES.*

By CHARLES H. HASWELL.

MARINE steam engines of the primitive construction were, down to 1822, of the vertical crosshead type, connected with sliding clutches directly to the water wheel shafts, and also geared to a shaft with a fly wheel at each end of it; the object of the connection was to enable the water wheels to be disconnected and the engine to be operated independently and solely to feed the boiler and operate the bilge pump when the vessel was at a pier or anchored, as independent steam, feed, bilge, and fire pumps were then unknown. The steam and exhaust valves, if puppet, were operated by the hand gear of Beighton; when otherwise, the long slide valve was used. This type of engine, with the crosshead, connecting rods, cranks, and shafts of cast iron, the key, crank, and holes cored and cast in, was wholly used until about 1822, when the vertical overhead beam was introduced; where the horizontal or inclined engine was introduced, the short slide valve was resorted to, except in the Southern and Western waters, where the lever puppet, operated by a cam, was wholly used.

The boilers, with the exception of the very first few, which were plain cylindrical, set in masonry, were of copper plates of the design termed "D and Kidney Flue," having but one furnace full width of the inner space of the front, the flame and gases of combustion leading through a flue of about two-thirds width of furnace into a back connection, and from thence into a return flue, which, from the outlines of its transverse section, was termed a "kidney flue," and from thence to a short vertical flue at the back of the furnace, and then extending up to the shell of the boiler, in a short shoulder of which the base of the smoke pipe was set. The cause of this convexity to the inner side of the main flue and the indentation given to the inner side of the other was that the curved surfaces rendered socket bolts less necessary, with the limited steam pressure of 15 pounds or less per square inch. On Southern and Western waters, where non-condensing engines were alone resorted to in consequence of the waters of the rivers being too turbid for the continuous operation of a condenser, wrought iron cylindrical boilers alone were used, and the character of the iron was such that the plates were cold riveted; the boilers were generally internally fired, in some cases externally, and it was not until about 1820 that marine boilers were constructed of iron in Eastern waters. Boiler plates were punched manually by the aid of a long wooden lever, on which four men exerted their force, and, as the location for the punch was directed only by the eye of the operator, the spaces were frequently irregular, involving pinning in order to bring the holes as nearly opposite as practicable, and hence the plates were frequently strained and the rivets set at an inclination; all rivets were hand made, but at the East were driven hot.

Blow-offs were not attached to boilers until steam navigation was well advanced. The exact period is not now ascertainable; probably about 1822. The boilers of steamboats on the bay and river routes, with the low pressure of steam with which they were operated, and the consequent temperature of it, did not involve the necessity of the frequent blowing off of saturated water from their boilers, and the water was let to run out of them at the end of each passage and they were then refilled with fresh water. In consequence of this neglect of blowing off, and the imperfect manner in which the plates of a boiler were riveted, a boiler at the end of a trip in wholly or even partially salt water would be loaded in its seams and joints with incrustations and stalactites of salt, to an extent that involved the hammering and scraping off of them at the termination of the trip. Felting of a boiler was unknown.

Cranks and Crank Pins.—The shaft hole of cranks was octagonal and they were secured to the shaft with flat keys, the interspaces fitted with a cement of iron borings and sal ammoniac; and as the distance between the centers of the crank, from the varying shrinking of the metal and the casual settling of the cores, would vary from that of the exact required length of half stroke of the piston, the pin was forged with two longitudinal centers, one for the hub and the other for the eye of the crank, and when the pin was fitted and seated it was held in position by a key in its end, which protruded beyond the eye of the crank.

Finishing.—So deficient were the facilities of lathes, planers, slotters, and drills that "black work" of engines, as it was termed, was the prevailing finish. The connecting rod of a large vertical beam engine in the "Victory" was wholly finished in the smith's shop, the body of it after forging being dressed by swaging, the key holes drifted, and the ends and straps dressed with a flatter on an anvil and a horse file. Cylinder piston packing consisted of hemp gaskets, and if the safety valve of the boiler was not raised during the initial raising of steam, the steam around the chimney flue would become so dry as to char the wood blocking between the ribs of the piston and also the piston packing; hence lead pipes through which the gaskets were drawn was resorted to. Counters, indicators, salinometers, brine pumps, steam and vacuum gages, metallic packing, whistles, and oil cups, other than the one in the cylinder head, by which the piston was lubricated on its exhaust side, were unknown. Cut-offs were operated by a cam on the water wheel shaft; hence, upon the closing of the cut-off valve, all the steam in the pipe between the valve and in the side pipe up to the steam valve was added to that expended without any effect that compensated for its flow, and as a result it was sought to save this expense, and Robert L. Stevens, of Hoboken, N. J., designed and successfully introduced the cutting off of the steam directly by the steam valve.

Compound or Woolf Engine.—In about 1824 James P. Allaire constructed the steamboat "Henry Eckford" with a vertical crosshead compound engine, the center shafts geared to the water wheel shafts, but in the absence of a receiver the mutual operations of the cylinders were only at the extreme of the opposite strokes of their pistons. Soon after and up to 1828 he constructed five other boats, namely, the "Sun," "Commerce," "Swiftsure," and "Pilot Boy," with like engines, and the "Post Boy" with an overhead beam engine, the cylinders being set at opposite ends of it; but as this type of compound engine operated at the moderate pressure of but 25 pounds per square inch, it did not attain such an effect as to justify the increased cost and weight of two cylinders and their connection, and the further construction of it was abandoned.

Steam Chimney.—In 1827 James P. Allaire, of New York, invented the steam chimney, the original design being that of two cylinders of boiler plate, one within the other, connected and closed at both ends, the interspace being about 5 inches in width, with a vertical diaphragm, connected near its upper end to the outer shell above where steam was admitted from the boiler through two or more connecting pipes, which served also as fastenings and to hold the chimney in position. This diaphragm led down to within a few inches of the bottom of the chimney, and the steam was inducted down and under it, then up and around the inner cylinder, and from thence to the steam pipe opening in the top; thus the steam deposited its contained water in the chimney, to be vaporized by the heat at the base of it, and received also heat from that ascending the chimney; hence a material economy of fuel was attained with the advantage of obtaining dry steam. Boilers at this period did not foam (prime); the great proportionate volume of water, its area at the water line, and the moderate heat in the furnace from wood, with but a natural draught, precluded it.

In 1828 the engine of a large steamboat, the "Chief Justice Marshall," on the route from New York to Albany, broke down by the breaking of the head of her piston rod at its insertion into the crosshead socket. The crosshead, both connecting rods, and a center crank were broken, and in four days new castings from the builder's patterns were made, the piston rod repaired, all fitted, and the engine ready for operation.

In this connection it is to be considered that neither the eye of the crank was reamed nor the key holes of the rods slotted; they (the crank eye and the ends of the rods) were submitted only to the operation of a coarse file.

In the attachments to engines and boilers the steam gages were constructed in the smith's shop, consisting of an iron tube ½ inch in diameter and 4 feet in length, bent, with one of its legs 15 inches in the clear in length and the other the balance of its length filled with mercury, on which was placed a light pine rod, the rise and fall of which, shown on a tin plate divided and numbered in inches, designated the pressure of the steam in pounds per square inch.

Steam navigation, up to the latter part of 1829, was confined to Long Island Sound, the Southern and Western rivers, and Canadian lakes and rivers, with a single passage of a steamboat from New York to Philadelphia, the "Phœnix," in 1807, and one on the route from Havana to Matanzas and one from Charleston to Savannah. In 1819 the auxiliary steamer "Savannah," of 380 tons, steamed and sailed from Savannah to Liverpool, she being the first steamer to cross the Atlantic Ocean.

In 1825 Mowatt Brothers, of New York, owners of the steamboat "Henry Eckford," attached a loaded barge to her and transported it from New York to Albany; this was the first essay of steam towing, and although insufficiency and impracticability were generally pre-

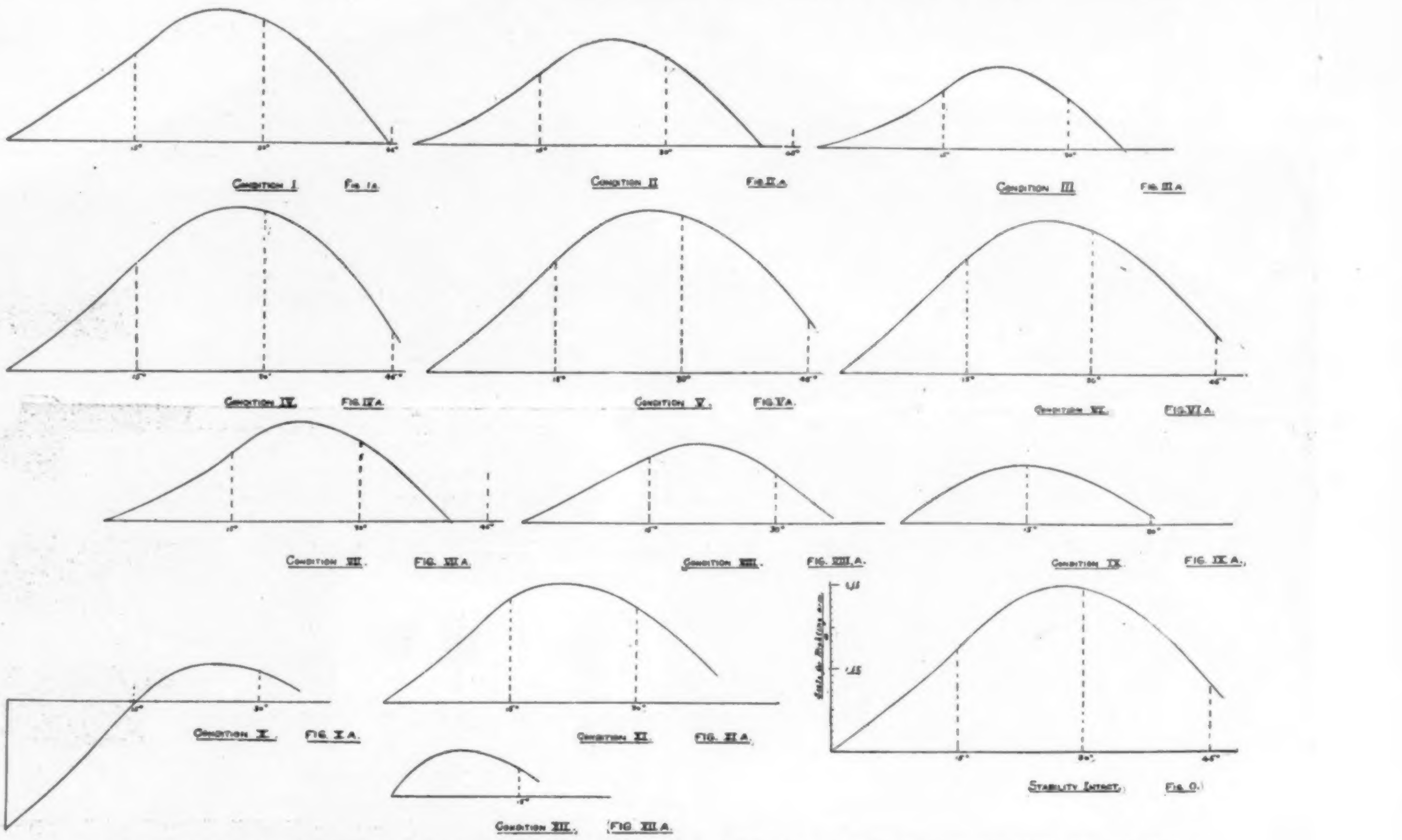


PLATE II.—CURVES OF RIGHTING ARMS CORRESPONDING TO DAMAGED CONDITIONS SHOWN IN PLATE I.

* Paper read before the Institution of Naval Architects.

dicted, the enterprise proved to be a great and lasting success.

In 1826 a fan blower was first introduced under the grates of the boilers in the steamboat "North America" of John C. and Robert L. Stevens.

In 1828-9 the rivalry for speed between the steamboats plying on the route from New York to Albany was so great that in the design of the boats their beam was so disproportionate to the weight of the engines, boilers, and deck houses above that they proved unstable, and in order to reduce this condition large logs of light pine wood with sharp ends were firmly suspended under their after wheel guards and depressed for half their diameter below the water line, and in operation they measurably improved the stability of the boats.

In 1830 the patent of the steam chimney of Mr. Allaire was invaded and the operation of it simplified by making the double cylinder an integral part of the boiler, open at its lower end and extending to such a height above the boiler as to give the necessary surface to superheat the steam, and the required height and volume of steam space measurably to arrest foaming by admitting the subsidence of the water physically borne with the steam in its flow to the steam pipe.

Gongs for the engine room were unknown, and in many of the boats, when the pilot was in his house, if there was one, or on the deck over the engine room, he would signal to the engineer by the strokes of a stick or cane upon the floor of the house or deck. All boats, of course, carried bells, and by them all notices of departure and of arriving were made known, and all salutes between boats were given by their bells. To blow steam, as is now done by a whistle, was intended and held to be a challenge or an insult.

Fuel, up to the year 1836, was wholly of pine wood, at which period some owners of steamboats commenced experimenting upon the practicability of using anthracite coal. A steamboat on her route of six or more hours could not have the capacity in her fire room to contain all the wood required and was compelled to pile it upon her side houses, and such boats as were on a long route, as from New York to Providence, were compelled to invade their upper deck with wood, and upon leaving the city had somewhat the resemblance of a floating wood yard.

In 1836 James P. Allaire commenced the running of a steamboat, the "David Brown," a light built river boat with deck houses and promenade deck, from New York to Charleston and return, the enterprise being almost universally held to be utterly impracticable. It was successful, however, and soon afterward he built two other and larger boats for the same route, and from that period coastwise steam navigation was held to be so practicable that various lines to other ports were established. The "David Brown" was fitted for this new service with planking under her water wheel guards closely joined and calked, extending from the inside of stringpiece to the light water line, which shielded the guards from being forced up by a sea. This device, after several essays at a proper term, is now known as the sponson. In some cases on coast routes, instead of a closed shield, open slatting was resorted to.

1837.—The first propeller steamer was introduced.

1838.—Phineas Bennett designed, patented, and introduced in the steamboat "Novelty," plying on the Hudson River, a vertical cylindrical boiler in which a hermetically closed furnace was supplied with air by a pump, and all the gaseous products of combustion of the fuel were driven into the steam room of the boiler; the object of this design was to increase the generation of steam and reduce the proportionate area of heating surface. The boiler after a short period of service was removed. Soon afterward he introduced the design into a vessel built to ply between New York and Liverpool, under the conditions with her builder that, if the design proved to be acceptably successful, he was to be paid for the entire plant of engines and boilers and his services; but if not successful, he was to remove the entire plant, and at his own expense, without any remuneration whatever. The engines and boilers were completed and operated, but they were not paid for by the builder of the vessel, and the boilers were soon after removed and replaced with others. In consequence of the ashes borne into the valve chests and cylinders, and the evaporation of the oil of lubrication by the dry heat of the steam, the valves were rapidly worn and the cylinder pistons shrieked to a degree that would have rendered the design very objectionable, even if it had been successful in other points.

Capt. John Ericsson arrived in New York in this year, and in 1842 he designed and directed the construction of the engines and propeller for the United States auxiliary bark-rigged steamer "Princeton."

1839.—Anthracite coal was introduced as fuel for steamboats, and, to aid its combustion when a high pressure of steam was required, a fan blower, driven by a belt from the water wheel shaft, was first resorted to, but soon afterward a small independent engine was resorted to, connected by a belt to the blower. Anthracite coal was soon afterward first burned without auxiliary draught in the open furnace of a steam boiler.

1840.—Wrought iron shafts were first made, the construction varying wholly from that of the present period; thus, iron bars from 2·5 to 3 inches square and of the greatest attainable length were laid up with a square section, abutting ends breaking joints with the other bars; hence the solidity of a section of the mass was only subjected to any imperfection arising from their ends not being wholly welded, by the percentage of the section of one bar to the whole number, and of all the shafts made up to the period included in this paper but one was broken; and that in consequence of its being insufficient in diameter for the stress to which it was subjected, and this result was foretold when the diameter of the shaft was reduced from that given in the specifications for it.

1842.—The first steam frigates for the United States were constructed.

1846.—Capt. John Ericsson applied a surface condenser to the engine of a revenue cutter, and in 1848 Pierson designed an improvement, which was further improved by Chief Engineer William Sewell, of the navy, and the perfected instrument is now in general if not in universal use.

1848.—The "Atlantic" and "Pacific," of the New York and Liverpool Steamship Company, Collins Line, were constructed in this year, and in July, 1850, the "Atlantic" made the then quickest passage between New York and Liverpool, it being but 10 days 15 hours. The "Arctic" and "Baltic," of the same line, were launched.

1850.—It is wholly impracticable to obtain the consumption of fuel per horse power in early steam engineering, as engines were not fitted with counters or indicators, and the wood was not weighed. In 1840, with auxiliary or blower draught, and in the absence of counters and indicators, it was computed by weighing the coal consumed, and held to be about 5 pounds, and the velocity of the river boats from 8½ statute miles in 1816 increased to 19 miles.

THE ERUPTION OF VESUVIUS.

SINCE the beginning of this century Vesuvius has seldom been quiet; almost every year there have been eruptions of greater or lesser importance, the most remarkable, since 1831, being the one that occurred in 1872. This year the volcano has been extremely active for months, and new craters have opened at the foot of the cone of ashes, from which streams of glowing lava issued, which soon filled the Atrio del Cavallo, between the volcano proper and the Somma peak, approaching the observatory.

On September 10 the volcano became more active. From that time on, masses of lava flowing from the main crater joined those that had come from the newly formed craters. By the 18th, the deep valley, Fosso della Vetrana, was filled with lava, and on that day the threatening flood reached to within 88 feet of the observatory, which was situated at a height of 2,000 feet above the level of the sea on the western ridge between the Fosso della Vetrana and the Fosso Grande.

As is usual when a great eruption occurs, the shape of the volcano has changed considerably, and seven new craters have opened about the main crater. The rain of ashes and stone, which was felt even in Portici, Resina, and Torre del Greco, destroyed the upper guides' huts, and several volcanic bombs fell on the upper station of the cable road and then made their way down to the foot of the cone of ashes.

Our engraving is a reproduction of a photograph taken on September 18, just at the time when one of the streams of lava, after crossing the road between

THE MOST RECENT ERUPTION OF VESUVIUS.—FROM A PHOTOGRAPH TAKEN SEPTEMBER 18, BY G. SOMMER, OF NAPLES.

the observatory and the lower station of the cable road, fell upon the house of the guides and the Carabiniere.—Illustrirte Zeitung.

PEKIN.

THE palace revolution that occurred a short time ago at Pekin has again attracted attention to a city that is extremely curious from more than one point of view, and concerning which there are many wonderful legends founded upon the tales of Marco Polo and the accounts of the Jesuit fathers who resided there in the last century.

The capital of China differs from all other cities in the world. It has no towering spires or graceful minarets, no lofty chimneys or high monuments, and no fine houses or buildings eight or ten stories high to be seen in the distance. There are no structures to be observed from the exterior except the walls, and these are nearly hidden by the houses and trees in the suburbs.

Pekin is in the form of a square, of which the sides are four miles in length, that is, to speak of the outside walls which inclose the Tartar City. There are nine gates in these walls, two on the east side, two on the north side, two on the west side, and three in the south wall, which divides the Tartar from the Chinese City. About a mile inside of these walls and in the center there is another walled city called the Imperial; again, inside of this there is what is called the Forbidden City, which also is walled, and inside this again are the palaces. Here the Emperor lives. No foreigner is allowed inside of the Forbidden City. The Chinese City is tacked on, as it were, to the south, and extends for about half a mile east and west beyond the walls of the Tartar City. It is inclosed by a wall about nine miles around, pierced for seven gates. It is smaller than the other city and was built one hundred years later. There are no fine buildings except the Temple of Heaven, and the streets are narrow and very dirty. Each city is surrounded by a moat crossed by bridges at the gates.

The wall of the Tartar City is fifty feet thick at the base, forty feet at the top, and fifty feet high. On the outer face, at intervals, there project massive square buttresses which enabled the archers to defend the spaces between them. At the gates there are inclined planes for mounting to the top. The wall was built in 1419. Each gate is surmounted by a house ninety-nine feet high, built with wooden pillars and galleries in Chinese style. There are no buildings in the city more than ninety-nine feet high, as the natives say that the spirit of the air flies at the height of one hundred feet. Each gate has a double entrance, formed by joining the ends of a semicircular wall to the main one, thus forming an enceinte of about an acre in area. The arches of the gates are of granite, and massive eighteen-inch thick wooden doors stop the opening, which is a tunnel fifty feet through the wall. These doors are closed every night at sunset and not opened for anyone until daylight next morning.

The moat that surrounds the city is fed by springs running from the western hills, and, as there are not many houses on the banks, the water is fairly pure.

All the principal streets running across the city from the gates are broad and unpaved. They are from one hundred to two hundred feet wide, but look broader owing to the lowness of the houses. They all run in straight lines from north to south and east to west. Nearly all of the shops are on these streets. Between the large streets there are smaller streets and lanes on which are situated most of the private houses, which present nothing but a brick wall and a door to the street. These lanes are very narrow and unpaved. As all the ashes and garbage are thrown into the streets, Pekin is gradually burying itself in its own refuse.

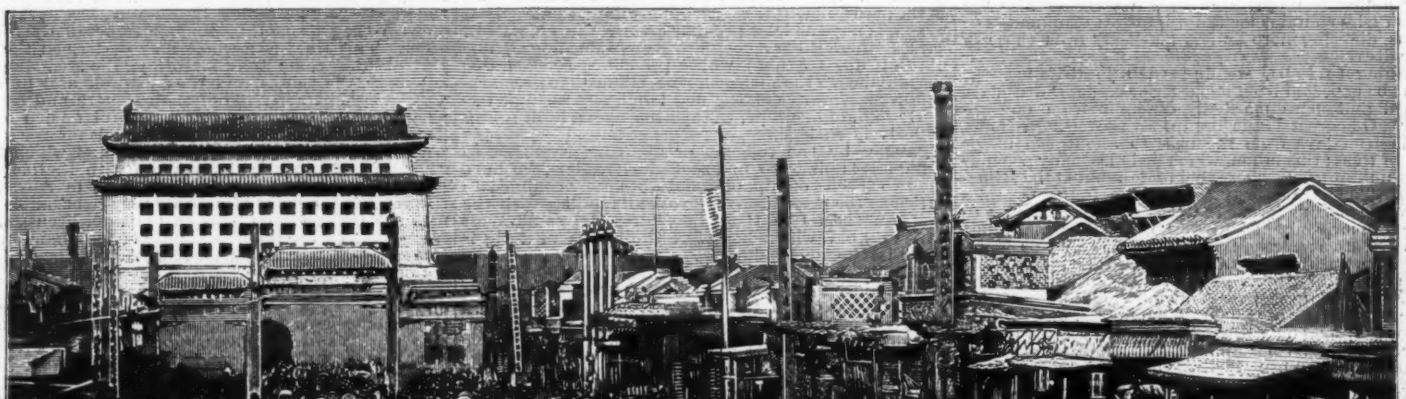
The most important gate is Hata-Men, the east one in the south wall that separates the two cities. Here all the goods that enter the city have to pay duty. To the south is Legation Street, on which are located the French, British, and other embassies. Proceeding westward from Hata-Men, we arrive at the center gate, which is the principal entrance to the city, and is called Ch'ien-Men. It differs from the others in having three entrances instead of one in the circling wall. The one opposite the main gate passes under a tall brick tower, and this is used only by the Emperor when on his way to the Temple of Heaven. The two side gates are used by the public, and here is the busiest place in the city. In front of the main gate is the entrance of the imperial palace, and on the other side ends the greatest business street, after traversing the Chinese City.

FRENCH LEGATION.

This thoroughfare, a view of a portion of which we reproduce herewith from Le Monde Illustré, must have been very grand at the time at which the wide slabs of sandstone with which it was paved, and most of which have now disappeared, offered to vehicles a very plane surface, instead of the deep gullies now found therein. The arches of triumph that stand here and there are now falling into ruin, and the space reserved for traffic has been gradually encroached upon by booths and temporary structures in which small dealers display their varied wares. This is one of the most animated spots in the city, and here are to be met with all the varied types of the Celestial Empire: the big-bellied and important trader mounted upon his mule or drawn in his cart, the mandarin in his sedan chair, the Chinese woman balancing herself upon her tiny feet, the beggar pursuing the pedestrian with his supplications or his abuse, and the peddler who displays his goods upon the roadway. This swarming crowd forms a compact mass whence exhales an odor that is rather disagreeable to a new comer. All the details are worthy of description, but we shall confine ourselves to saying that, although cries and disputes are frequent here, affrays are rare, since the Chinese is very pacific in his manners and does not willingly expose himself to blows. He has a very practical mind, is capable of deriving profit from the least thing, and turns his entire activity toward trade. If to this we add that he has a horror of innovations, we shall understand how it is that the government of the mandarins, despite its iniquities and exactions, has not been overthrown.

Protected in the interior by the apathy and indifference of the population, this government has been able to defend itself from the attacks of the exterior by exploiting the jealousy of the powers and in opposing the covetousness of one to that of the other. Menaced on the north and south by the combined efforts of Russia and France, and in the center (in the valley of the Yang-Tse) by England, it has gained time by seeking aid, now from one and now from another; and, when it saw itself threatened by Japan, it was to Europe that it owed its safety. Many a time, in moments of difficulty, high mandarins, and princes even, have been obliged at night to cross the threshold of the legations to invoke the aid of the western "barbarians" for whom they affected so much disdain among themselves.

Installed in the ancient palaces of high Chinese personages, the residences of the envoys of the European powers are almost all situated upon the same street, which the Chinese call by a name signifying the Street of Nations, and which extends from the Ch'ien-Men to



PEKIN—GREAT BUSINESS STREET OUTSIDE OF THE CH'IEN-MEN GATE.

the Hata-Men. Of these the Russian legation is the oldest, it having existed in Pekin for over a hundred years. There is nothing in particular to call attention to in these structures, which are built in the usual Chinese style of one story, with a large courtyard in front. They are nearly all situated in parks surrounded by high walls. Near the legations are the principal government offices.

One of the characteristics of Pekin is that all the public buildings are covered with colored glazed tiles, every dynasty having its own color. The present dynasty, which is the ch'ing or "pure," has adopted yellow. All the palace buildings, as well as the top of the wall of the Imperial City, are roofed with tiles of this color.

The method of lighting the streets is of a very primitive character, the lamps being substantial wooden affairs glazed with paper and supported by four legs. The light is obtained from a wick placed in oil contained in a small clay saucer, and just serves the purpose of preventing persons from running into the lamp. As the lamps are lighted only on moonlight nights, they may be credited with illuminating the city. Considering the rapidity of the Russian advance into Manchuria, however, it is permissible to believe that this state of things will not last long, and that the time is not far distant when Pekin will be lighted with electricity and when mechanical propulsion will replace the clumsy public vehicles which the foreign residents call "carts."

AFRICA AND ITS ANIMALS.

By R. Lydekker, B.A., F.R.S., in Knowledge.

If we take a map of the world, and, after tracing upon a sheet of thin paper the outline of the British Islands, cut out the tracing and lay it upon India, we shall find that it covers a mere patch of that great area. Repeating the same process with India, and placing the tracing thus obtained on Africa in such a manner that the sharp angle on the tracing formed by Assam overlies the projecting point of Somaliland, which it almost exactly covers, it will be found that the area embraced in the tracing occupies only a small patch in the middle of the eastern side of the Dark Continent. As a matter of fact, the patch thus marked out ends in a blunt point northwardly some distance above Khartoum, thence it runs south to the neighborhood of the Victoria Nyanza, from which district it rapidly narrows to terminate in a sharp point some distance to the southward of Zanzibar. Allowing for some slight overlaps, no less than six Indias can be traced on the map of Africa; and as these leave between them and on their margins considerable spaces of the country still uncovered, it would be but a moderate estimate that Africa includes at least seven times the area of British India. Some idea, especially to those familiar with our vast Indian dominions, may in this manner be most readily gained of the huge extent of the African continent.

Having made these comparisons of the actual size of the three areas under consideration, I must ask my readers to regard them for a moment from another point of view. Everyone familiar with the birds and mammals of the British Isles is aware that, even excluding Ireland, the same species are not found over the whole area. The Scottish hare, for instance, is specifically distinct from the ordinary English kind, while the red grouse is unknown in the southern and eastern counties of England, and the ptarmigan is confined to the colder districts of Scotland. There are accordingly indications that even such a small area as the British Isles contains local assemblages of animals, or faunas, differing more or less markedly from those of other districts.

Turning to India, we find such local faunas—as might be expected from its larger area—more distinctly defined and more markedly different from one another. One great fauna occupies the southern slopes of the Himalaya from the base to about the upper limit of trees; this fauna, which includes many peculiar types unknown elsewhere, being designated the Himalayan. The second, or typical Indian fauna, occupies the whole of India from the foot of the Himalaya to Cape Comorin, exclusive of the Malabar coast, but inclusive of the north of Ceylon. The third, or Malabar fauna, occupies the Malabar coast and some of the neighboring hills, together with the south of Ceylon; the animals of these districts being very different from those of the rest of India. The fourth, or Burmese fauna, embraces only the province of Assam, in what we commonly term India; and many of its animals, again, although of the general Oriental type, are very different from those of the other districts. But even such divisions by no means give the full extent of the local differences between the animals of the whole area. In the second or typical area, for example, the creatures inhabiting the open districts of the Punjab and the Northwest Provinces display remarkable differences from those dwelling in the forests of Southern India (the home of the strange loris); while the dwellers in the jungly tract of the southwestern districts of Bengal are equally distinct from those of either of the other areas.

Seeing, then, that while slight differences are observable in the local faunas of such a small area as the British Islands, and that much more important ones characterize the different zoological provinces of the vastly larger extent of country forming British India, it is but natural to suppose that distinctions of still higher value would be characteristic of different parts of Africa, accordingly as they differ from one another in climate, and consequently in vegetable productions.

As a matter of fact, such differences do occur to a most marked degree; but when the vast superiority, in size, of Africa over India is taken into consideration, the marvel is that the fauna of the greater part of that area is not more dissimilar than it is, and that it has been found possible to include the more typical portion of the continent in one great zoological region or province.

But the reader will naturally inquire what is meant by calling one portion of a continent more typical than the rest. As has been pointed out in an earlier article in this journal,* Northern Africa has, so far as its animals are concerned, been cut off from the districts lying south of the Tropic of Cancer by the great barrier formed by the Sahara; and as the animals of the districts to the north of that desert are for the most part of a European type, while Southern Europe and Northern Africa were evidently joined by land at no very distant epoch of the earth's history, the districts north of the Sahara are for zoological purposes regarded as part of Europe and Asia. Typical or Ethiopian Africa, as it is more generally termed, includes, therefore, only such portion of the continent as lies to the south of the northern tropic.

* "Deserts and their Inhabitants," Knowledge, May, page 101.

But the critical reader may perhaps here be led to remark that some at least of the animals of Northern Africa are common to the south; the lion, whose range extends from Algeria to the Cape, affording a case in point. To this it may be replied that, popular prejudice notwithstanding, the lion cannot in any sense be looked upon as a characteristic African animal. Although year by year growing rarer, it to this day still lingers on in certain parts of Western India, while it is likewise found in Persia and Mesopotamia, and within the historic period was common in Southeastern Europe. At a still earlier epoch, as attested by its fossilized remains, it was an inhabitant of our own island. It may, therefore, to a certain degree be regarded as a cosmopolitan animal, which may have obtained entrance into Africa by more than one route. In a minor degree the same may be said of the hippopotamus, which was formerly found in the lower reaches of the Nile, and at a much earlier epoch in many parts of Europe, inclusive of Britain. Being an aquatic animal, it can avail itself of routes of communication which are closed to purely terrestrial creatures.

Of the fauna of typical Africa, as a whole, some of the most striking features are of a negative nature; that is to say, certain groups which are widely spread in most other districts of the Old World are conspicuous by their absence. This deficiency is most marked in the case of bears and deer, neither of which are represented throughout the whole of this vast expanse of country. Pigs allied to the wild swine of Europe and India are likewise lacking, their place being taken by the bush-pigs and the hideous wart-hogs, both of which are among the most characteristic of African animals. Except for a couple of species of ibex in the hills of the northeast, sheep and goats are likewise unknown in a wild state. Among other absentees in the fauna, special mention may be made of marmots, and their near allies the susliks, as well as of voles, beavers, and moles.

Of the mammals (and space permits of scarcely any reference to other groups) which may be regarded as characteristic of typical Africa as a whole, the following, in addition to the bush-pigs and wart-hogs already mentioned, are some of the most important. Among the monkeys the most widely distributed are the hideous baboons (Papio), now restricted to Africa and Arabia, the southern portion of the latter country being included in the same great zoological province. The guenons (Cercopithecus), species of which are the monkeys commonly led about by organ-grinders, have also a wide distribution on the continent, although of course more abundant in the forest regions than elsewhere; and the guerezas (Colobus), one of which was described some months ago in Knowledge,* have also a considerable range. In a totally different group, the curious little jumping shrews (Macroscelides) form a peculiarly characteristic family of African mammals belonging to the insectivorous order. There are also many peculiar genera of mungooses, but as most of these have a more or less local distribution, they can scarcely be considered characteristic of the continent as a whole; still they are quite different from those found elsewhere. A very curious carnivorous mammal known as the aardwolf (Proteles), strikingly like a small striped hyena, is not the least peculiar among the animals of Africa, where it has a comparatively wide range. The hunting dog (Lycaon), which presents a considerable resemblance to the spotted hyena, is an equally remarkable representative of the dog family. Although formerly found in Europe, the spotted hyena itself is now exclusively African.

Passing by the rodents, or gnawing mammals, as being less familiar to non-zoological readers, we have the two species of hippopotami absolutely confined to Africa at the present day; we are all familiar with the common species in the "Zoo," but the small West African kind which has more the habits of a pig is much less commonly known.

The stately giraffes are solely African, but appear to be mainly confined to the more open districts. The herds of antelopes, for the most part belonging to generic types unknown elsewhere, with the exception of a few in Arabia, form one of the most distinctive features of African life. Many of them, like the strange gnus and the graceful gemsbok group, are confined to the open districts of the south and east; but others, such as the bush-bucks and the harnessed antelopes, have representatives in the forest districts of the west. Both species of African rhinoceros are quite different from their Oriental relatives, but only one of these, the common species, has a wide distribution in the country. Zebras, and the now extinct quagga, are familiar and striking African animals, although they are confined to the open plains and mountains. On the other hand, the African elephant, which differs so widely in the structure of its teeth from its Asiatic relative, has a much more extensive distribution, and may therefore be classed among the most characteristic of Ethiopian animals. Even more peculiar are the little hyraces (Procavia), the miscalled coneys of our version of the Bible, which form a family absolutely peculiar to Africa, Arabia, and Syria; some of the species dwelling among rocks, while others are active climbers, and frequent the forest districts. But perhaps the strangest mammal that may be regarded as characteristic of Africa as a whole is the aard-vark (Orycteropus), commonly known to the colonists as the ant-pig. It is a strangely isolated creature, having at the present day no near relations, either poor or otherwise.

The African buffaloes, with their several races or species, also belong to a type quite peculiar to the continent. To a great extent the ostrich is characteristic of Africa and Arabia, although there is evidence to show that it formerly enjoyed a considerable range in parts of Asia.

The above are only a few of the more striking instances showing how different are the animals of Africa as a whole from those of the rest of the world. Many others might be added, but they would only weary my readers. Of course there are many groups, like the cats, common to other countries, the lion and the leopard being found alike in Africa and India; but such do not detract from the peculiarity of the African fauna as a whole. And here it may be mentioned that a large proportion of the types now peculiar to the Dark Continent appear to have come from India or some adjacent country, fossil remains of baboons, giraffes, hippopotami, ostriches, antelopes of an African type, and not improbably zebras, having been discovered in the Tertiary deposits of India.

* June, 1897, page 130.

But if the animals of Africa as a whole stand out in marked contrast to those of the rest of the world, much more is this the case when those characteristic of certain districts of that huge continent are alone taken into consideration. And most especially is this so with the inhabitants of the great tropical forest districts extending from the west coast far into the interior of the continent—reaching, in fact, the watershed between the basins of the Congo and the Nile in the neighborhood of Wadelai. Since a large number of the peculiar animals of this district are more or less exclusively confined to the west coast, extending from Sierra Leone to the Congo, the area is appropriately termed the West African sub-region. It is here alone that we find the gorilla and the chimpanzee, the former being restricted to the neighborhood of the coast, whereas the latter ranges far into the heart of the continent. And this district is likewise the exclusive home of the pretty little mangabys, or monkeys with white eyelids (Cercocebus). The galagos, which are near relatives of some of the lemurs of Madagascar, extend throughout the forest region; but the even more curious pottos, or thumbless lemurs, are confined to the west coast. Huge and forbidding fox bats, some of them with remarkable tufts of long white hairs on the shoulders, are likewise restricted to this portion of the tract, as is the insectivorous otter, or Potamogale, first discovered during the travels of Du Chaillu. The equatorial forest tract is also the sole habitat of the African flying squirrels, distinguished from the very different flying squirrels of Asia by the presence of a number of scales on the under surface of the tail. Most of these belong to the genus Anomalurus, but the smallest of all forms a genus (Idiurus) by itself, and will be familiar to readers of this journal by a life-sized portrait published some years ago. Dormice of peculiar types and tree mice are also very characteristic of this tract. But far more interesting are the pygmy hippopotamus of Liberia and the water chevrotain (Dorcatherium) of the west coast, an ally of the true chevrotains of India and the Malay countries. So far, indeed, as the equatorial forest tract fauna has any representative in other parts of the world, it is to the Malay peninsula and islands that the resemblance is closest. It is there alone that the other large manlike ape—the orang—dwells; and there is a group of brush-tailed porcupines common to these two districts, and unknown elsewhere throughout the wide world. Both faunas, however, in all probability trace their descent from the animals inhabiting Europe during the Pliocene and Miocene epochs, among which was an extinct species of water chevrotain.

The other great sub-regions include the open grazing grounds and mountains of South and East Africa, the fauna of which is quite different from that of the equatorial forest tract. Minor divisions may also be recognized in this area, the cape having many animals not found further north. Among the latter are the so-called white rhinoceros, the pretty little meerkat (Suricata), the long-eared fox (Otocyon), and the cape sand mole (Bathyergus), which, by the way, has nothing to do with the true moles, being a member of the rodent order. This tract as a whole may be termed the east central sub-region; and to it belong the great hosts of antelopes, the zebras, and the aard-wolf and hunting dog. Very characteristic of the southern and eastern parts of this tract are the beautiful golden moles (Chryschloris), unique among mammals for the lovely play of iridescent colors on the fur, and which have comparatively nothing in common with the moles of Europe and Asia. To the northward, in Abyssinia, this tract is the home of another very remarkable animal, the great gelada baboon (Theropithecus), easily recognized by the lionlike mantle of long hair on the fore quarters, whose nearest relatives are the ordinary baboons of Africa.

Whether Somaliland should be included in this area or should have a division to itself, may admit of argument; but, at any rate, it has many peculiar animals, among which are a number of antelopes, some of which have but recently been made known to science.

Lastly we have the Saharan sub-region, which contains a comparatively limited fauna, passing by almost insensible degrees into that of Northern Africa.

In some respects, especially in its galagos, the fauna of Africa presents a certain resemblance to that of Madagascar; but the connection between that island and the mainland was evidently very remote, and must have taken place before the great incursion of antelopes, zebras, rhinoceroses, monkeys, elephants, etc., from the north, as none of these are found in the island. Madagascar, therefore, is best regarded as forming a zoological province by itself.

Within the limits of a single article it is manifestly impossible to give anything like an adequate sketch of the fauna of such an extensive area, but such points as have been noticed serve to show in some faint degree its richness in peculiar forms of animal life.

The Maryland State Geological Survey has just received from France a machine for testing the wearing power of various kinds of rock and stone, which has been in use for some time by the French government. It is composed of duplicate revolving cylinders and is worked in a unique manner. The cylinders are hollow and allow a good-sized piece of stone to be placed inside of each. The rod of the machine is attached to a motor, and the cylinders revolve rapidly a number of thousand times. They are opened then, and the fine material that has been ground off is gathered up after the stones have been washed, and is weighed. In this way the experience of years can be gathered in a few hours. Calculations can be made from the result to just what extent the stones experimented with would wear if placed in a roadbed or used to build a highway or public building. The machine is a very valuable one, and Prof. William Bullock Clark, State Geologist, superintended its erection.

ELECTRICAL NOTES.

It may surprise American electrical engineers who have been congratulating themselves of late on the use of American electrical machinery in foreign lands to find that three large direct-coupled alternators have been built by Messrs. Brown, Boveri & Company, Baden, Switzerland, for an American gold mining company, says The Electrical World. The machines are of the flywheel field magnet type, mounted on the shafts of three cross-compound horizontal Allis-Corliss engines.

A Trial of Sectional Conductor Traction in England.—A practical trial of electric traction in the streets with the so-called closed conduit system of current supply, but more properly termed a sectional conductor system, has been on trial in Leeds. One mile and a half of track has been laid in a hilly suburb of the city, with underground switches supplying current to the car through phosphor bronze buttons in the streets and skates carried by the car. It is said that the tests proved the system to be very satisfactory.

An electrical omnibus has lately been put in service experimentally in Berlin. According to a German contemporary, the 'bus has accommodation for twenty-six passengers, measures 23 feet in length by 6¼ feet in width, while its weight, including the battery, is 6·65 metrical tons. The battery, which consists of 120 cells, contained in 24 boxes, weighs about 1¾ tons, and is stated to have a capacity sufficient to run the vehicle a distance of 60 kilometers (37½ miles) at a speed ranging from 6 to 12 kilometers per hour. The motor is geared to the front axle of the omnibus.

According to The Financial News, it should not be long now before telegraphic communication with the Klondike region is established, some sanguine people even predicting that it will be open in January, though this is very unlikely. The Canadian Parliament in the beginning of the year granted a charter to some English and Canadian investors, empowering them to construct a telegraph line from the Alaska coast to Dawson City. Nothing was done, however, during the summer, and the charter has come into possession of another body possessing greater energy. The plan is to construct a double land line from Skaguay via Lake Tagish and Fort Selkirk to the Klondike. The work is to be begun immediately, and the line is expected to be in operation early next year.

In England, as is well known, the government operates what is known as the post office telegraph system. The revenue from post office telegraphs, it seems, is rapidly growing, the increase in this revenue for the half year ending September 30, 1898, as compared with that the corresponding half year of 1897, being about $350,000; but it is pointed out by London Engineering that while this revenue grows, the working expenses have an awkward tendency to grow also, and, upon the whole, in at least an equally rapid ratio. Engineering, which is in a position to criticise with intelligence, feels that this increase in working expenses is inexcusable, and it states that "telegraph business, if conducted by the state at all, should be carried out by it upon sound and reliable business principles."

Prof. W. Peukert contributes an interesting article on the measurement of high voltages to the Elektrotechnische Zeitschrift of September 29. He appears to acknowledge the superiority of direct electrostatic measurements, but thinks that a different method is also necessary to calibrate and check the high pressure voltmeters. He considers the potentiometer method unreliable for alternating currents on account of the difficulty of making resistances sufficiently free from self-induction. Transformer methods are not to be depended on absolutely, owing to their transformation ratios not being constant. The method he recommends is the subdivision of the potential difference to be measured by a number of similar condensers in series across the terminals, and the accurate measurement of the potential difference between the two coatings of one of these.

It has been suggested by several people that the recent wreck of the Mohegan on the Manacles Rocks was due to a local deviation of the compass of the ship. In a letter to The London Times, Prof. A. W. Rücker points out that a disturbance of a magnitude sufficient to have caused the disaster is most improbable. He remarks: "During the magnetic survey of the United Kingdom, carried on by Dr. Thorpe and myself, observations were made at twelve places in Cornwall. Of these, Lizard Down, Porthallow, and Falmouth were the nearest to the scene of the disaster, and at all of them the deviation of the compass from the normal magnetic meridian was extremely small. The largest disturbance of this kind which was observed in Cornwall occurred at St. Levan, near the Land's End, and only amounted to eleven minutes of arc, or less than two-tenths of a degree. The largest disturbance of the dipping needle was at Mullion, and was only fourteen minutes."

One of the best evidences of the value of lightning rods up to date has been afforded by the Washington Monument. It is capped by a small four-sided pyramid of aluminum, which metal, so cheap to-day, was very costly at the time of the building of the greatest obelisk that the world has ever known. This aluminum tip is connected with the ground by four copper rods which go down deep into the earth. On April 5, 1885, five bolts of electricity were seen to flash between the monument and a thunder cloud overhanging in the course of 20 minutes. In other words, the monument was struck fiercely five times, but it suffered no damage whatever. On June 15 of the same year a more tremendous assault was made upon the monument from the heavens, and the result was a fracture of one of the topmost stones. The crack still remains to show what nature can do in the way of an electrical shock, but the slightness of the damage is evidence of man's power to protect himself from such attacks. The obelisk is ideally located for attracting electrical assaults from the skies, and yet, while many times hit, it has suffered only once, and that time to a trifling extent. The Statue of Liberty, New York Harbor, is protected by copper rods united to the figure and extending through the pedestal to copper plates buried in wet ground beneath the foundation. Lightning has never injured the statue in the least.

MISCELLANEOUS NOTES.

An eminent man of science has recently declared that red-haired people are far less apt to go bald than those with other colored hair. The average crop on the head of a red-haired person is only 29,200 hairs. Ordinary dark hair is far finer, and over three dark hairs take up the space of one; 105,000 are about the average. But fair-haired people are still better off; 140,000 to 160,000 are quite a common number of hairs on the scalp of a fair-haired man or woman.—Humanitarian.

A record was made on the Brighton Railway recently, the new Sunday Pullman from Victoria to Brighton making the distance in a few seconds less than an hour. The 10½ miles of suburban railway between Victoria and Croydon was covered in fifteen minutes. On arrival at Redhill, the train had completed 20¾ miles in exactly twenty-seven minutes. From East Croydon to Preston Park took 41 minutes 47 seconds (39 miles), and from Redhill to Preston Park (nearly 28¾ miles), 29¾ minutes.

An example of wanton waste in public administration is pointed out by The Philadelphia Ledger, in the use of the electric light in the city hall in that city. The current is supplied by the Public Buildings Commission, but this body has no control over its use in the various departments, and those responsible are indifferent. It is not at all uncommon, The Ledger reports, to see the finance committee's room with every lamp in its starry ceiling ablaze with light, and not a person in the room. The great audience room of the mayor is not infrequently seen with its 180 lamps shedding their radiance solely for the delectation of the colored messenger, who has, perhaps, an hour before, thrown on the switch to show the room to some visitor. Room after room in which the sun's rays are so fierce as to compel the inmates to drop the window shades, will have the electric lights all burning. In other rooms the sun's rays beat upon burning lamps. The size of the leak has nothing to do with the immorality of it, but, as figured up by The Ledger, it would be enough to provide school room for many of the hundreds of children who are now deprived of their rights in the matter of an education. It is a moderate estimate that a third of the electric current furnished is wasted. When all the departments are in operation, one-third of the current produced for the six hours during which the offices are occupied daily would, at the rates paid to the electric companies, cost not less than $60 a day. That is not the full measure of the loss, however, as a large number of the lamps burn uselessly twenty-four hours in the day.

In regard to the production of acetylene gas from calcium carbide in France, there are no official statistics bearing upon the annual output of calcium carbide, so that the amount furnished yearly by the different manufacturers has to be estimated, says the American consul at Havre. These estimates vary from 1,000 to 5,000 tons per year from each factory. There are ten factories at present engaged in the manufacture of carbide of calcium in France. Two are at La Bathie, and one each at Séchilienne, Froges, Chapareillan, Lancey, Notre Dame de Briançon, St. Béron, Bellegarde, and Crampagna. Four factories are under construction. They will be situated at St. Etienne de Maurienne, Epierre, Serres, and Chute du Giffre. They will be able to produce, when running at their full capacity, from 2,500 to 3,000 tons per year. The wholesale price of carbide of calcium in France is from 350 to 400f. ($67.55 to $77.20) per ton, exclusive of cost of packing. The cost of packing is 4.50f. (87c.) per iron drum containing 50 kilogrammes (110 lb.), 6f. ($1.19) per drum of 100 kilogrammes. The carbide of calcium manufactured in France is guaranteed to give 300 cubic liters of gas per kilogramme. The output is constantly increasing, and the supply is fully equal to the demand. The retail price of the article is from 55f. to 60f. per 100 kilogrammes ($10.20 to $11.58), not including packing. There are two villages in France completely lighted by acetylene, by the Société Franco-Espagnole du Gaz Acétylène, of 81 Rue St. Lazare, Paris. They are Alzonne, in the department of Aude, a town of 1,506 inhabitants, and Saurat-par-Tarascon, in the department of Ariege, a place of 3,024 inhabitants.

The United States Navy Department is having a ship model cutting machine made by the Detrick & Harvey Machine Company, of Baltimore, Md. The purpose of this machine is to cut from a built-up block of white pine or other wood a model of the hull for a government ship of the same form and dimensions as a light skeleton form. This skeleton is built up of ribs of wood of the proper dimensions and sheathed with thin wood. This machine, says The Iron Age, is about 35 feet long, 20 feet wide, and weighs about 40,000 pounds. In a general way it consists of a middle platform, on which is fixed the skeleton model, and above the skeleton is placed a block of wood from which the model of the hull is to be cut. On either side of this platform are two beds, each 35 feet long, on each of which slides a saddle or carriage carrying an electrically driven cutting mechanism with its operator. The work on the model is performed by cutters connected through a parallel motion, and is guided by a former roll bearing against the surface of the skeleton just referred to. This roller follows the lines of the skeleton, and through the parallel motion the cutters accurately duplicate these lines. The cutters are driven by electric motors, as also are the two carriages moved along the beds. After the model has been cut and is practically a duplicate in solid wood of the built-up skeleton form, it is placed in the testing tank recently constructed at the Washington navy yard. This tank is about 550 feet long and 60 feet wide. On either side of the tank are tracks, and upon these tracks is placed a model towing carriage driven by electricity to run at various uniform speeds from the slowest up to an actual speed of not less than 2,000 feet per minute. By means of electrical devices, through the medium of mathematical calculations, displacement of the model, power required to tow it at certain speeds, and other necessary data in determining the lines of the hull are ascertained. The lines of the model, if not satisfactory, can be readily changed, and through further experiments in towing satisfactory results are arrived at.

SELECTED FORMULÆ.

Wood Staining.—The following recipes for stains for imitating various woods are given by Oils, Colors, and Drysalteries:

1. Lemon Wood.—This can be imitated by immersing sycamore wood in a hot solution of gamboge in turpentine.

2. Coubaril Wood.—Maple, sycamore, or beech is dyed in a hot decoction of logwood or Brazil wood, and then washed over with sulphuric acid.

3. Black Ebony.—(a) After saturating the surface of the wood with a solution of sulphate of iron let it dry, and then apply a hot decoction of logwood and nutgalls till the required tint is obtained. When the surface has dried, wipe off all superfluous dye and finally polish with linseed oil.

(b) Immerse beech, plum, pear, alder, lime, sycamore, or plane tree wood in a hot infusion of logwood. When dry, mordant the wood with a cold solution of acetate of copper.

(c) Immerse the wood into a cold solution of the sulphates of copper and iron acidulated with oil of vitriol. When the wood is sufficiently impregnated with the mordant, place it in a bath containing pyroligneate (crude acetate) of iron, logwood, and gall nuts, and heat to 60–100° C.

4. Red Ebony.—Sycamore previously mordanted with alum is steeped in a hot decoction of Brazil wood. When the surface is dry, apply a cold solution of copper acetate.

5. Jacaranda or Violet Wood.—(a) Immerse walnut, alder, cherry, or beech in a hot decoction of Brazil wood and potash. Put in the black veins afterward by means of a brush charged with solution of sulphate of iron.

(b) Soak pear, beech, ash, elm, alder, poplar, or birch for twenty-four hours in a hot solution consisting of walnut shells 5 parts, acetic acid 1 part, water 80 to 100 parts. Finally dry in the air.

6. Lignum Vitae.—Having steeped plane, sycamore, or beech in a hot decoction of madder, apply oil of vitriol, and wash as soon as the desired effect is obtained.

7. Mahogany (Light).—(a) Prepare a tincture with dragon's blood 4 parts, washing soda 1 part, methylated spirits 60 parts. This may have to be strained. Apply it to the wood, previously wetted with dilute nitrous acid and allowed to dry. One or more applications must be made, according to the particular shade required.

(b) Immerse sycamore or maple in a hot decoction of Brazil wood.

(c) Treat cherry wood with lime water for twenty-four hours, and then steep it in a hot infusion of mahogany sawdust.

(d) Immerse sycamore or lime in a hot decoction of madder.

(e) Walnut previously passed through nitric acid, or which has stayed some time in strong lime water, is dried and polished with oil colored with orchil, and then varnished with red varnish. This recipe is said to give specially good results. Walnut is a wood closely resembling mahogany in the grain, so that it lends itself to the purpose with particular readiness.

8. Mahogany (Fawn).—Steep maple or sycamore in hot infusion of logwood.

9. Mahogany (Red).—Immerse white walnut in a hot decoction of Brazil wood, or sycamore in a hot infusion of annatto and potash.

10. Mahogany (Dark).—(a) Boil 1 pound of madder and ¼ pound of logwood chips in 2 gallons of water, and apply the hot liquid thoroughly with a brush. Then allow the surface to dry, and go over it with a solution of 1 ounce of pearlash in a gallon of water.

(b) Put poplar, acacia, alder, poplar, or lime into a hot decoction of Brazil wood and madder.

(c) Make a tincture by dissolving 4 parts of dragon's blood, 2 parts of alkanet and 1 part of aloes in 120 parts of spirits of wine. Apply this to the wood with a brush.

(d) Steep chestnut in a hot solution of gamboge.

(e) Steep sycamore, beech, or cherry in a hot decoction of logwood. The last two woods should be first mordanted with lime water.

11.—Oak.—(a) Boil 10 ounces of Vandyke brown, 2 ounces of bichromate of potash, 2 ounces of washing soda, and 4 ounces of carbonate of ammonia in a gallon of water for seven or eight minutes. Apply the solution obtained to the wood.

(b) The appearance of age can be given to new oak wood by exposing it to ammonia gas. To imitate old oak on ash, elm, box, alder, chestnut, maple, yew, or sycamore, acetate of iron or nitrate of copper, or both, can be made use of. The tints can be varied at pleasure by using the metallic salts separately or mixed, and by giving them various degrees of dilution. They should be used cold. Weak solutions of acetate of iron give green shades, and stronger ones various hues of brown, darkening as the concentration of the iron salt increases.

12. Rosewood.—Boil 1½ pounds of logwood chips in a gallon of water until the volume of the infusion is reduced to 2 quarts. Apply this boiling hot. If more than one application is necessary, the wood should be allowed to dry before a fresh brushing over is done. The finished surface must be grained with a camel-hair pencil dipped in logwood infusion containing the sulphates of iron and copper.

13. Walnut (Black).—Infusion of walnut shells was formerly used to color white walnut, alder, poplar, or beech, but the process at present in vogue is to boil a mixture of 2 parts of Cologne earth and 1 part of potash in 12 parts of water until the volume is reduced to rather less than half, and to apply the resulting liquid to the wood cold with a pad or brush. Potassium permanganate can also be used.

Tomato Ketchup.—

Ripe tomatoes	3 dozen.
Chillie vinegar	1 pint.
Garlic	1 ounce.
Shallots	1 "
Common salt	2 "
Cayenne pepper	¼ drachm.
Lemon juice	5 ounces.

Put the tomatoes into a jar and warm in an oven until tender. Cool, skin, and pulp the fruit, and add to the liquor in the jar, along with the rest of the ingredients. Mix well and bottle.

MR. HENRY SAVAGE LANDOR "IN THE FORBIDDEN LAND."*

IT is seldom that a book of such enthralling interest as "In the Forbidden Land" comes to the table of the book reviewer. The book is a record of a journey in Tibet undertaken by Mr. Landor during the spring, summer, and autumn of 1897. It is illustrated by his photographs and by sketches made on the spot, and even while a prisoner he made observations which enabled him to prepare a map of 12,500 square miles of Tibet proper. Although Mr. Landor failed to reach Lhassa, his objective point, the geographical results of his expedition are valuable. They were as follows:

First, the solution of the uncertainty regarding the division of Mansarowar and Rakastal Lakes; the ascent to so great an altitude as 22,000 feet and the photographing of the features of some of the great Himalayan glaciers; the visits to and the fixing of the position of two possible sources of the Brahmaputra never before reached by a European. Owing to the publicity given to the Tibetan abuses taking place on British soil, the government of India has notified the Tibetan authorities that they will, in future, not be permitted to collect land revenue from British subjects near the border.

The Tibetans are an intensely cowardly and cruel people, and it is to be hoped that some time they will be severely punished for their actions in this and other connections. It seems as though nothing could be said in favor of this barbarous people, and a people who eat their dead should not be allowed to exist at the present time.

The plateau of Tibet, the so-called "Country of God," is absolutely forbidden to the European, and it is surprising that Mr. Landor did not imitate the example of Richard Burton when he made his famous visit to Mecca some fifty years ago, by learning the language, disguising himself, and practicing the customs. Mr. Landor had some experience in exploration, but hardly enough for him to throw precaution to the winds. Had he been more careful, the concrete results of his expedition would have been greater, but this in no way detracts from the merit and picturesqueness of the volumes. Early in the journey Mr. Landor's intentions became known, and then there was no chance of his reaching Lhassa; for the spies communicated with the sacred city, and officials and military parties ordered, implored, and even tried to buy him off, all to no purpose. Mr. Landor's tortures were always stopped short of inflicting fatal injuries, and as he was returned alive to India, we must conclude that while the Lamas wished to punish the Englishman and deter future travelers, they did not intend to kill him, for England has a long arm and she never fails to exact prompt retribution for the death of any of her sons. How often in England does the poacher or other trespasser pay for his trespass with his life? and the inhabitants of Tibet have some rights, and while we deplore Mr. Landor's tortures, his deportation was within bounds.

Mr. Landor arrived in India on the 10th of April, 1897. He proceeded to Almora, where he arrived on April 27. He remained at Almora until May 10, to make arrangements for his travels in Tibet. On the 27th of May he arrived at Garbyang, near the boundary line of Southwest Tibet. His adventures were of a peaceful nature, and the difficulties which he encountered were largely owing to the extremely mountainous character of the country and to the glaciers, etc. His experience with the Raots, near Askote, were very interesting, and he was enabled to obtain an excellent knowledge of the manners and customs of this strange people. The people on the border have had very sorry experiences with the Tibetans, who exact tribute from them.

When Mr. Landor arrived at Garbyang, near the boundary line of Tibet, he attempted to make immediate arrangements to enter the closed country. He used some care to keep his movements secret, but he found they had been divulged to the Tibetan authorities, so that they kept themselves constantly informed of his movements.

The Jong Pen of Taklakot, on hearing of Mr. Landor's proposed visit, sent threats that he would confiscate the land of any man who came in his employ, and made a promise to behead Mr. Landor and any one caught with him. When Mr. Landor arrived at Garbyang, he found that the Jong Pen was kept fully acquainted with his movements. The latter's spies went daily backward and forward with details about him. One of Jong Pen's emissaries, a stalwart Tibetan, had the impudence to enter Mr. Landor's rooms, and informed him that the British soil on which he was standing was Tibetan property. He declared the English were cowards. This remark was too much for Mr. Landor, and he grabbed him by his pigtail and landed in his face a number of blows. When he let him go, the wretched Tibetan threw himself down crying and imploring Mr. Landor's pardon. Mr. Landor then forced him to lick his shoes clean with his tongue. This done, he tried to scamper away, but the plucky Englishman seized him by his pigtail, and kicked him down the front steps which he dared to come up unasked. Chanden Sing, Mr. Landor's servant, kept up the good work, and the Tibetan made his escape under a shower of blows, and hauling around the yard by his pigtail, until Mr. Landor interfered to stop the sport. Although this may have afforded a little diversion, it was doubtful if actions of this kind prejudiced the Tibetans in favor of the Englishman. Mr. Landor devotes several chapters to interesting information of the Shokas, including their marriage customs, etc. He left these good people with regret and pursued his travels. He founa a bridge over a stream had been destroyed to prevent his passage. With great difficulty he succeeded in obtaining a force of thirty men to transport his provisions, ammunition, scientific apparatus, etc.

Without intending to be so, Mr. Landor is humorous, for he describes the inevitable Englishman's cold bath in the ice-cold streams of this high altitude. He says: "Before starting I took my shower bath in a cold stream and rubbed myself over with snow. I found this very invigorating, and with the reaction I experienced a delightful glow of warmth, notwithstanding the thin clothes I was wearing."

From this point on the party had to struggle up mountain passes and across glaciers, dragging their sheep with them. It was a serious matter camping at an altitude of 16,150 feet, considering that the highest mountain in Europe is but 15,781 feet. In climbing one of the peaks the bulk of the party was left below, while Mr. Landor and Dr. Wilson and a few natives climbed the peak.

At 20,500 feet Dr. Wilson was forced to stop, and Mr. Landor with two natives went ahead. One of them dropped in the snow at an altitude of 21,000 feet and went instantly to sleep. Mr. Landor and one attendant reached the top of the peak at last. Observations were made, and it was found an altitude of 22,000 feet was registered on the instrument.

On July 13 Mr. Landor entered Tibet. He reached Gyanima, where he was stopped by the Barkha Tarjum. This personage, after some persuasion, consented to permit Mr. Landor and seven followers to go forward to the Mansarowar Lake. Next day the accorded permission was withdrawn, and Mr. Landor and his party were turned back. The party returned three marches, when he determined to go on to Mansarowar by the unfrequented wilds.

On the 21st of July Mr. Landor, with nine followers, climbed up the mountain in the midst of a terrific snowstorm, and the bulk of the party continued their retreat. By this strategic movement Mr. Landor was enabled to baffle the Tibetan guards. Of thirty picked servants with which Mr. Landor entered Tibet on July 13, only two remained on July 21, the bearer Chanden Sing and a coolie Man Sing.

Despite his misfortune, Mr. Landor determined to push on to Lhassa. This was known to his deserting followers, who gave the information to the Tibetans. He went over the Marium Pass, which attains an altitude of 17,500 feet, and which no Englishman has ever before penetrated. A source of the Brahmaputra, one of the largest rivers of the world, was then discovered. While crossing the Nio Tsambo River one of Mr. Landor's yaks (a beast of burden) went under, and though the animal was saved, its valuable load of money, provisions, and ammunition was lost. This accident was directly the cause of Mr. Landor's capture, as he and his two followers were driven to seek food and horses from the inhabitants of the cold and inhospitable country—a thing which he had carefully avoided doing before by keeping to the high mountains and unfrequented wilds. The inhabitants made all manner of excuses for their failure to supply food. Mr. Landor met a Tibetan "army," and when the officer offered him a sheep if he would go back, the plucky Englishman said, "And I will give you this to make you go back," and knocked him down. The officers ran away screaming. It seems all through the narrative that Mr. Landor was too free with his fists, so that the sympathy we might have in his subsequent tortures is somewhat alienated.

At Toxem, on August 29, 1897, Mr. Landor and his servants were selecting ponies when they were overcome by numbers and securely tied. It took five hundred Tibetans all counted to arrest one starved Englishman and his two half-dying servants, and then they did not dare to seize him openly, but had to resort to treachery! The pockets of the prisoners were rifled, and when the watches and chronometers were broken they were pronounced "dead." Chanden Sing was tied and flogged and Mr. Landor was struck with the butt of a whip. The prisoners were separated during the night. They were brought before the "Pombo" or governor of the province, who officiated in his dual capacity as governor and Lama. Mr. Landor refused to kneel to this dignitary, and even requested him to use colloquial language and not classical Tibetan. Chanden Sing was soundly flogged, and Mr. Landor's plan of not showing either pain or fear succeeded remarkably well. Mr. Landor was forced to ride for miles on a saddle provided with four or five sharp iron spikes projecting from the back of it. These caught the small of the back, producing intense pain and serious injury. The pony was constantly lashed and Mr. Landor's iron handcuffs penetrated to the bone. On reaching Galshio, on August 21, he was made to stand on a prismatic shaped block of wood, his legs being forced as far apart as possible; one ruffian seized him by the hair, while a bar of iron was being heated in a brazier. The Pombo seized it and said jeeringly that since he (Landor) had gone to see the country, he should have his eyes burned out. The Pombo brought the red-hot bar of iron parallel to and about an inch and a half from Mr. Landor's eyeballs and all but touching the nose. The heat was intense and his eyes were greatly injured and his face terribly burned, but fortunately his eyesight was preserved. The Pombo then tried (?) to kill the Englishman with a matchlock, but the gun, owing to an overcharge, flew out of the Pombo's hand without doing any damage. The executioner then brought his sword down very close to Mr. Landor's neck twice, once on each side, but the Pombo finally determined not to go on with the execution. Mr. Landor's arms were secured to a pole by ropes, his feet being still tied to the prism of wood. This formed a kind of rack, and his servant, Man Sing, was also fastened the same way. The pain caused by the position was, of course, severe. Mr. Landor was tortured in this manner for twenty-four hours and his servant twelve hours. To add to their misery they were kept in the rain and were seated in a pool of water. Mr. Landor did not recover the use of his legs for sixteen hours, and he then feared they were mortifying. On the afternoon of the third day the two prisoners were taken on foot to Toxem. They were then taken in the direction of Mansarowar Lake. On their arrival there the guards unbound Mr. Landor. At Dogmar the party was

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MR. LANDOR AND HIS SERVANT ON THE RACK.

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MR. LANDOR LED CAPTIVE.

* "In the Forbidden Land." Account of a journey into Thibet, captured by the Thibetan lamas and soldiers, imprisonment, torture, and ultimate release brought about by Dr. Wilson and the political Peshkar Karak Sing-pal. By A. Henry Savage Landor. With 1 photogravure, 8 colored plates, 50 full page and about 150 text illustrations, and a map. In two volumes. Royal octavo. Harper & Brothers, New York city.

stopped by the Jong Pen of Taklakot, who refused to give them passage through his district. This was a very serious affair, for it meant that the worn-out prisoners would have to take a circuitous route to India, which probably would have caused their death from exposure. The Rev. Mr. Wilson and one of the native authorities of a contiguous section of India compelled the official to remove his prohibition and give his sanction to the prisoners being conveyed to Taklakot. The prisoners were hospitably received by the Rev. Mr. Wilson, who is also a medical man, and he examined their dreadful injuries and attended to them. The Tibetan guards made over some of Mr. Landor's property, but of course a great deal of it was irreparably damaged, while his dry plates, which would have presented simply invaluable memoranda of the trip, were destroyed.

The account of Mr. Landor's adventures is so extraordinary that the government made an investigation into the affair under the care of Mr. J. Larkin, a magistrate, who corroborated Mr. Landor in every particular. Mr. Landor held Chinese passports, and his conduct during his stay in that country did not warrant the officials in treating him in that cruel way.

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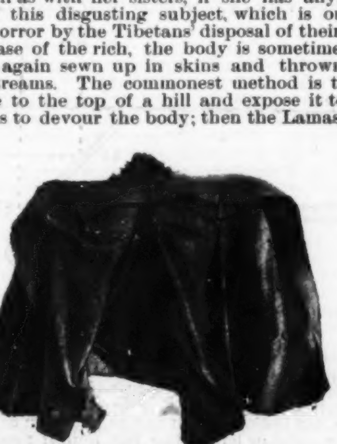
SPIKED SADDLE.

The Appendix to "In the Forbidden Land" contains various documents and depositions which fully corroborate the statements made in the book. The volumes are filled with information regarding the Tibetans, their customs and habits, though space forbids us to do more than refer to a few of them.

The Tibetan woman is superior to the Tibetan man, but is not prepossessing. Mr. Landor covers the matter in saying that he "saw women who were less ugly than others." With filth that is undisturbed by bathing and with never changed clothes, it is not likely that they would appeal to an Englishman. The women wear trousers and boots like the men, and have, in addition, a long gown reaching to their feet. The hair is carefully parted in the middle and plastered with melted butter over the scalp as far down as the ears. There is no standard of morality among unmarried women of the middle class, and the marriage customs are peculiar. If an eldest son marries an eldest sister, all the sisters of the bride become his wives. Should he, however, begin by marrying the second sister, all the sisters of the bride, from the second down, become his property, and so on. The bridegroom's brothers are all regarded as their brother's wife's husbands, and they one and all cohabit with her, as well as with her sisters, if she has any. But enough of this disgusting subject, which is only excelled in horror by the Tibetans' disposal of their dead.

In the case of the rich, the body is sometimes cremated or again sewn up in skins and thrown into running streams. The commonest method is to take the corpse to the top of a hill and expose it to dogs and ravens to devour the body; then the Lamas circu-



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COAT TORN BY SADDLE.

late around it, using their prayer wheels, and, finally, all sit or squat down near the body. The Lamas with their daggers cut to pieces what remains of the flesh. The higher Lama eats the first morsel, then the other Lamas and the relations proceed with this ghastly ceremony until all the bones are clear and dry.

In case a man dies of a pestilence, the birds and dogs and relations will not go near the corpse, but the Lamas will devour all the rotten human flesh. It is natural and hardly to be regretted that such ceremonials should result in many deaths from cadaver poisons.

The chapters devoted to Mr. Landor's visit to a Lamasery and Temple are very interesting. He was able to get much information from the Lamas relative to their religion. Each monastery has a number of Lamas of high position and as its head a grand Lama, which should not be confounded with the Dalai Lama of Lhassa, who is believed to have an immortal soul transmigrating successively from one body to another. All the larger Lamaseries support one or more sculptors, who travel all over the district and go to the most inaccessible spots to carve on rocks, or stones, the everlasting inscription "Omnia mani padme hun." Sometimes these inscriptions are of colossal size. These words refer to the reincarnation of Buddha from a lotus flower. The prayers of the Lamas are of a singularly conventional type. They use the mechanical prayer wheel revolved by hand, wind power, or water power. They seem entirely ignorant of the nature of spiritual prayer. In Tibet, as in other Buddhist countries, there are nunneries besides the Lamaseries, but the less said of them the better. The Lamas themselves are the worst specimens of a thoroughly beastly people. They particularly relish human blood, which they drink out of a cup made from a human skull.

MESSAGE STICKS.

By R. H. MATHEWS, Esq., L.S.

MESSAGE sticks, or, as they are sometimes called, "talking sticks" or "blackfellows' letters," have occasionally been referred to by writers on the customs of the Australian aborigines, but comparatively little information has been recorded on this subject. From inquiries I have made personally, and through numerous correspondents in different parts of Australia, I am forced to the conclusion that the value of "stick letters" as a means of conveying information from one tribe to another at a distance has been considerably overrated and misunderstood. To the student of ethnology, however, they are highly interesting, as showing an attempt by a primitive and uncultivated people to develop some method of communicating their thoughts to others by means of symbols.

Speaking in general terms, the stick is given to the messenger to assist him in remembering the heads of the message by connecting them with certain pictures, marks, or notches cut upon it, which are explained to him before he sets out on his journey. The stick also serves as his credentials, being a confirmation or guarantee of the genuineness of the message.

These "stick letters" are pieces of wood of different sizes, varying in length from about an inch and a half to eighteen inches or more. They are in some cases flat pieces of wood, ornamented more or less by carving, and are often painted a bright color; in other instances they are merely a rounded piece of wood, or a rod cut from the branch of a tree or sapling; while a still more primitive kind are made of a piece of bark. Instances have been observed where marked pieces of bone were used in a similar manner. They are marked in various ways, consisting of notches, dots, strokes, curves; and also with triangular, quadrilateral, and zigzag devices. In some of the more elaborately carved there are rude representations of human beings, while in some tribes they are not marked at all, but consist of a plain piece of wood. "Stick letters" summoning festive gatherings are sometimes decorated with the down of birds, with or without other marks. In some tribes the wood used for making the stick must be of the same totemic division as the sender of the message; and the man who carries it must also belong to that division. Many of the devices on these sticks are apparently for ornamentation only, and would depend upon the artistic skill of the maker. The marks are cut upon them with a piece of sharp stone, bone, or broken shell.

These "talking sticks" appear to have been made according to some conventional design known among the tribes using them. One kind of stick is used for a corroboree where a large number of people assemble; another is used to convey messages or reminders between friends residing at some distance from each other; a certain sort of stick would be used for festive gatherings, another in cases of sickness or death, and so on. These sticks, differing perhaps but little in general appearance, would, nevertheless, be recognized by the people inhabiting the tract of country in which they are used, and would thus, to a certain extent, have a more or less fixed significance, which would, however, be very much restricted and of little use, unless accompanied by a verbal explanation by the bearer.

Message sticks are used in summoning an assembly for hostile purposes, meetings for corroborees, and the other gatherings and greetings referred to in the last paragraph. The messenger who carries the stick and message is generally a young man, strong and active, and a good traveler, who is, therefore, well qualified to discharge his duties. He is generally more or less known among, or is related to, the tribes he visits, and is, to some extent, acquainted with their dialect. On his arrival at the men's camp, he hands the message stick to the person to whom he has been directed to deliver it, giving the name of the sender, and explaining the meaning. The party who receives the "stick letter" carries it with him when he goes to the place to which he has been invited. Sticks, conveying friendly messages or greetings, could be carried by the women and youths, as well as by the men. There being no urgency for the speedy delivery of these friendly messages, they are not generally sent direct, but may be a considerable time in reaching their destination. A messenger sent to a tribe to report the death of a relative or person with whom the sender of the information was acquainted would have his face painted with pipeclay.

The bearer of a message is never molested by any of the tribes through whose country he may have occasion to travel while engaged on this duty, even although the people through whom he may pass are not on friendly terms with his tribe. As far as I can learn, this rule is of universal prevalence among native tribes throughout the continent, and a breach of it would lead to retaliation.

The practice of using marked pieces of wood to accompany messages sent from one tribe to another may have been copied from some of the invading races who came to Australia in the remote past, and has been handed down in a rude form to the present day. The custom has been observed among the aborigines in different parts of Australia, but was much more highly developed in some districts than in others; and was, so far as I can learn, altogether unknown among some tribes. The latter statement should, however, be tested by further investigation.

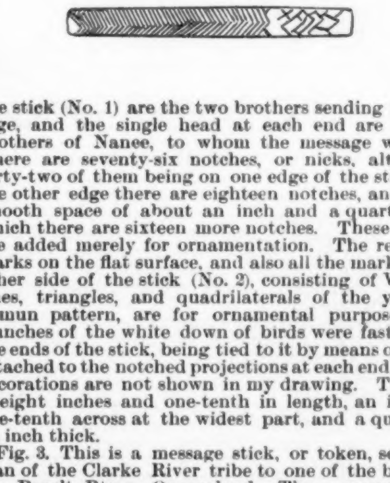
Meetings for the performance of the initiation ceremonies are summoned by a messenger carrying a bullroarer, the several articles comprising a man's dress, some native weapons, and occasionally a quartz crystal. Having already given complete details of how these important messages are delivered in my articles describing the initiation ceremonies of several native tribes, it is unnecessary to refer to them any farther at present.

Although the Australian "stick letters" were not of themselves sufficient to convey any intelligible meaning beyond the crudest kind, there appears to be some evidence that they were a rude kind of picture writing, which would perhaps have developed into a more connected and useful form in process of time. It is well known that gesture language was more or less extensively recognized and understood among all Australian tribes. Gesture language may be called "idea speaking," and pictographs "idea writing." It has been said that written syllaburies and alphabets have been developed from pictographs, and it is suggested that in the picture writing of different races the beginning of our modern manuscripts and principal books are to be found.

From a number of message sticks in my possession I have selected three, shown in the annexed illustration, which are drawn to a scale of three inches to one inch lineal of the sticks from which they are copied.

Figs. 1 and 2. These drawings represent the two sides of a message stick made by Belay and Kunganooey, two brothers of the Kubbi section and iguana totem, both of whom are chief men of the Tinanburra tribe, and was dispatched to Nanee, Kumbo Kangaroo, one of the head men of the Culgoa tribe, residing near Goodooga. The makers of the stick gave it, together with a verbal message, to a blackfellow whose name I did not learn, who brought it from Tinanburra to Toulby, a distance of about sixty miles, where he handed it over to a Kubbi iguana, a man of the Culgoa tribe. This man brought it to Tatalla, on the Culgoa River, about ten miles from Toulby, where he met "George," a half caste, a Kubbi padamelon, who is a "tracker" attached to the Goodooga Police Station, and who was then at Tatalla on official duty. George then brought the stick on to Goodooga, and handed it to Nanee, the man to whom it was originally sent, together with the verbal message he had received from the man who gave it to him at Tatalla. This message was to the effect that Belay and Kunganooey requested Nanee and his two brothers, Bindi and Bunjalah, to come to Tinanburra for the purpose of joining them in a big corroboree which was shortly to be held there. Tinanburra is on the Cuttaburra River in Queensland, and Goodooga is on the Bokhara River in New South Wales, the distance between the two places being upward of a hundred miles.

The two heads alongside each other in the middle of



1

2

3

4

the stick (No. 1) are the two brothers sending the message, and the single head at each end are the two brothers of Nanee, to whom the message was sent. There are seventy-six notches, or nicks, altogether, forty-two of them being on one edge of the stick. On the other edge there are eighteen notches, and then a smooth space of about an inch and a quarter, after which there are sixteen more notches. These notches are added merely for ornamentation. The remaining marks on the flat surface, and also all the marks on the other side of the stick (No. 2), consisting of V-shaped lines, triangles, and quadrilaterals of the yammunyamun pattern, are for ornamental purposes only. Bunches of the white down of birds were fastened on the ends of the stick, being tied to it by means of strings attached to the notched projections at each end. These decorations are not shown in my drawing. This stick is eight inches and one-tenth in length, an inch and one-tenth across at the widest part, and a quarter of an inch thick.

Fig. 3. This is a message stick, or token, sent by a man of the Clarke River tribe to one of the blacks at the Basalt River, Queensland. The messenger who brought it said it was a reminder to the Bluff Downs natives to bring plenty of handkerchiefs and other fancy things when they next visited the first mentioned tribe. The length of the stick is five inches and three-eighths and its diameter half an inch. It is simply a round piece of wood, one-third of the circumference of which is shown in the drawing, the remainder being marked in the same way. The markings consist of V-shaped or zigzag lines, cut with tolerable regularity and sameness throughout the whole length of the stick.

Fig. 4. The message stick here represented is a round piece of wood, a little over half an inch in diameter and six inches long, and is painted red. It was sent by one of the blacks on the Clarke River to a blackfellow known as "Billy," residing at Bluff Downs station, on the Basalt River, asking him and his people to come to the Ana Branch, as a big corroboree was coming off. The localities mentioned are in the North Kennedy district, Queensland. The stick is marked all over in a somewhat similar manner to Fig. 3.

The foregoing article is abridged and revised from a paper contributed by me to The American Anthropologist, Washington; Vol. X., pp. 288–297; plate vii.

HIGH SPEED TELEGRAPH TRANSMISSION BY MEANS OF ALTERNATORS.

ALTHOUGH, at the present day, high speed transmission is much more limited in its application than at an earlier period in the history of telegraphy, owing to the commercial aspects of the question having been unavoidably altered, attempts have been made from time to time to produce improvements in this direction; but until lately the admirable system invented by the late Sir Charles Wheatstone, and considerably improved by the British Post Office Telegraph Administration, has been the best available method of automatic high speed signaling.

The speed at which a series of waves can be passed over a given line depends primarily and inversely upon the product of the total resistance into the total capacity, the form of the wave having a considerable influence on the speed where any measurable capacity is present.

In the ordinary Wheatstone automatic fast speed system of telegraphy, the letters are formed by waves of different duration, a dot being produced by a short wave, a dash by a longer one. This renders it necessary to charge the line longer for a dash than for a dot, which is a grave defect in fast speed working; but the condenser compensation, introduced and employed by the British Post Office, practically doubles the speed attainable on any given line by, in some measure, equalizing the line charges. That is to say, the condenser used is always of a capacity which admits of a full charge during the time interval of a dot, and a current of the duration of a dash does not give the condenser any higher charge. Indeed, condenser compensation has such a beneficial effect, that the defect of unequal impulses is almost overcome, inasmuch as the increase of speed obtained by this arrangement and equal impulses is only five per cent. greater than that obtained with currents of unequal duration. Again, although the signals be made equal in this system, another difficulty presents itself; that is, the waves that are sent through the line are the results of the sudden applications of the full E. M. F. used (in practice, 100 volts), and consequently a reversal means a sudden change of 200 volts, i. e., from 100 volts positive to 100 volts negative. The form of the current wave with such a system depends almost entirely on the nature and form of the circuit. It is easy to produce correspondingly sudden and complete changes in the current when the circuit possesses only resistance, but when capacity, etc., is present, the form of current wave is vastly different to the impressed E.M.F. wave; for example, take the letter "A." The actual current curve on a land line without condenser compensation is shown in Fig. 1, while Fig. 2 represents the effect of shunted condenser compensation.

FIG. 1.

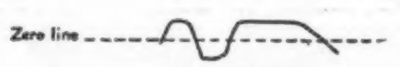


FIG. 2.

Prof. A. C. Crehore, of Dartmouth College, U. S. A., in conjunction with Lieut. G. O. Squier, of the United States Artillery, have, however, been led to make some experiments with alternators, and have suggested a mode of high speed signaling which, although presenting some mechanical difficulties, has recently been tried by the inventors of the Post Office telegraph lines in England, under the direction of Mr. Preece, and found to produce a distinct increase of speed.

Fig. 3 shows an ordinary sine wave as produced by an alternator, and it is this form of wave that Messrs.

FIG. 3.

Squier and Crehore use in their so-called "synchronograph" system of fast speed telegraphy.

The signals are obtained by the omission of certain complete cycles or semi-cycles, the message being read by means of the blanks in the regular succession of recorded dots; or signals can be recorded on chemically prepared paper.

This system is to some extent a synchronous one, with this great advantage over the many well known synchronous systems, that the synchronism is not required between the transmitter at one end and the receiver at the other end of a line, but between the alternator and transmitter at the sending end of the line. This is easily obtained by driving the transmitter from the generator shaft. The transmitter itself is exceedingly simple, and consists of a wheel the circumference of which is one continuous conductor, presenting a smooth surface for the brushes to bear upon. If the periphery of this wheel be divided into forty equal parts, and be geared to run at one-fourth the speed of the armature of a ten-pole alternator, clearly one of these equal parts will correspond to one semi-cycle of E.M.F. produced by the alternator. Upon the surface of the wheel bear two brushes, carried by an adjustable brush-holder. One brush is joined to the generator and the other to the line, so that the current entering one brush from the generator passes across the transmitting wheel to the other brush, and thence out to the line.

Now, if a piece of paper $\frac{1}{40}$ of the circumference of the wheel be fixed thereon in such a position as to pass under one of the brushes, one semi-cycle or half wave of current will be omitted in every twenty complete waves, and by means of a suitably prepared paper ribbon, or "slip," any combination of signals can in this simple manner be transmitted. The brushes are adjusted so that the periods of disconnection and connection coincide with the zero points of E.M.F. The transmitter may, however, have only one brush joined to line, and the wheel itself may be made the connection to the generator. With this mode of signaling much higher E.M.F.'s may be used, and connections and disconnections made almost without spark at the brush contacts.

The speed of the transmitting wheel with respect to the generator shaft is immaterial, the essential being that its circumference should contain an integer number of times the arc which a point fixed with respect to the field would describe on such circumference during one semi-period of current.

Complete control of every semi-cycle of current thus permits the maximum speed of transmission of signals with a given frequency. If the transmitter does not act in synchronism with the generator, the "make" and "break" of the circuit occurs when the current is not naturally zero, and considerable interference results; care is, therefore, taken to insure that the "slip" admits of the line connections being made at the proper times only.

Although the received signals were originally intended by Messrs. Squier and Crehore to be recorded on chemically prepared paper, they have also devised a very ingenious massless receiver, although at present it is not in a practical form. It is based on the well known discovery of Faraday that a beam of polarized light may be rotated by means of a magnetic field, the direction of rotation of the ray being the same as the direction of the current producing the field; the rotary power depends upon the intensity of the magnetic field, and the total amount of rotation upon the length of the rotary medium in which this magnetic field exists and through which the ray passes.

The method adopted is to pass a beam of light through a Nicol's prism, thence through a long tube with plane glass ends containing liquid carbon bisulphide, and afterward through a second Nicol's prism. The ray of light is received on a screen having a sensitized surface, which is carried forward at a uniform speed; a long coil is wound round the tube containing the carbon bisulphide, the prisms being adjusted so that no light passes through the tube when no current is flowing through the coil, the source of light being an arc lamp.

The passage of a current rotates the polarized ray within the tube, and the light then falls on the sensitized screen, and is thereby recorded.

As neither of these methods of reception is suitable for everyday use, the British Post Office undertook, in conjunction with the inventors, a series of valuable and interesting experiments over the departmental lines under more practical conditions. The existing departmental records of capacity, resistance, and mileage, compiled for the whole country, proved invaluable by supplying exact data for each of the experiments performed, and enabled reliable tables and curves to be constructed. The experiments consisted of determinations of the highest limits of speed for the Wheatstone automatic, as well as the synchronograph system on various lines, the following combinations being specially compared:

1. Ordinary Wheatstone automatic with condenser compensation as is used at present.
2. The synchronograph sine wave transmission system with chemical receivers.
3. A combination of the synchronograph sine wave transmission with Wheatstone receivers.

The alternator used for these experiments consisted practically of several separate alternators on one shaft, each being independent of the remainder, and so constructed that, with the same speed of revolution, different frequencies or wave speeds could be obtained, transformers being used in those cases where it was desirable to maintain the E.M.F. unaltered.

Careful estimations were made not only of the force employed, which is about 50 per cent. higher than that ordinarily used on Wheatstone circuits, but also of the wave speed, and its equivalent value in "words per minute" in each case.

On a line from London to York and back, mainly composed of copper, having a total mileage of 431½, and a K.R. equal to 33,000, a speed of 540 words per minute was attained with Wheatstone receiver and Crehore-Squier transmitter (synchronograph), although the maximum limit was not reached. The speed obtainable with this K.R. being only 360 when ordinary Wheatstone automatic was used.

From London to Aberdeen and back, with a total mileage of 1097½ and a K.R. of 261,000, a speed of 135 words per minute was obtained by the Crehore-Squier Wheatstone combination, as compared with 46 words per minute on the ordinary Wheatstone automatic with the best compensating arrangements.

These two cases are typical of the whole series of observations, which enabled the comparative wave speeds of the different systems to be estimated as follows:

Wheatstone automatic alone	1
Crehore-Squier transmission and Wheatstone receiver	2·9
Crehore-Squier transmission and chemical receiving	2·9

In the first two cases the number of waves necessary for each word is of course the same, but in the last named case, where chemical receiving is employed, a further gain is obtained by using fewer waves for each word, making the word speed in the three cases bear the ratio 1, 2·9 and 7.

Chemical receiving is by no means so convenient as ordinary Wheatstone, and the most pressing practical requirement at the present day is not higher speeds for short distances, but higher direct working speeds over long lines where at present intermediate "repeaters" are necessary.

It is satisfactory to note that the maximum wave speed attainable by synchronograph transmission with the chemical receiver or with the Wheatstone receiver is exactly the same on any circuit where the speed is limited by the line itself and not by the receiving apparatus.

On the Wheatstone system shunted condensers are necessary to compensate for two distinct effects—the unequal duration of the signals and the inductance of the receiver. Where the synchronograph transmission is employed on short cables or open lines, no line compensation is required, and a fixed condenser can be shunted across the receiver coils so as to compensate for the inductance of the receiver for any given speed. In connection with this question the inductance of the Post Office receiver was carefully verified, and was found to be 3·46 henries, the necessary condenser compensation depending solely on the speed of transmission (or wave-frequency) and the arrangement of the receiver coils, and in no instance having any direct or complicated relation to the line capacity.

On an artificial cable, equal to about 200 miles of ordinary submarine cable, where condenser compensation is used at both ends, the increase of wave speed obtained by the synchronograph was only 50 per cent., instead of 190 per cent., as in the case of open wires. It would therefore appear that with further experiment some line compensation might be found to be necessary for cable working.

The experiments show that where the capacity of the line is not great, as in the case of aerial lines, the transmission of the current in sine waves produces the best results, and leaves the factor of the inductance of the receiving instrument to be dealt with separately, and consequently in a more exact manner.

The principal difficulty in the application of the system is the necessity for the use of a new code of signals, or a reduction in the speed value to admit of conformity with existing codes. The existing Wheatstone automatic instruments are also light, portable, and adapted for use in outlying districts at short notice, where the synchronograph would probably be found to be less suitable. The perforator at present in use for the preparation of the transmitting "slip" has also, by a process of evolution, become extremely convenient and equally suitable for hand working in confined spaces or where power is available.

A suitable and easily manipulated perforator for the synchronograph has yet to be devised. Messrs. Squier and Crehore, however, deserve great credit for the discovery, with limited means of experiment, of an improved and promising system of high speed transmission.—*Nature.*

A MIRROR PSEUDOSCOPE AND THE LIMIT OF VISIBLE DEPTH.

By Prof. G. M. STRATTON, University of California.

IN the course of an interesting review of recent work on the visual perception of depth,* M. Bourdon comes to the question why the heavens seem the particular distance above us that they do. In substantial agreement with Lipps, he explains the matter as arising from the limitations of binocular vision. There is a limit beyond which all objects appear equally distant, so far as immediate stereoscopic appreciation of their positions is concerned; so that the stars cannot be directly felt as farther than the maximal range of binocular effectiveness. This maximum, therefore, whatever it may be, fixes for us the distance of the vault overhead. Taking an angle of 60″ as the threshold for the perception of spatial differences in the visual field and 65 mm. as the average interocular distance, he computes the range to be about 220 meters, and believes that this agrees fairly well with the apparent distance of the sky.

By a similar computation, after experiments in discriminating the distances of objects less than a meter from the eye, Helmholtz† gives "240 meters or more," as an estimate of the extreme distance at which an object might still appear in stereoscopic relief against a background infinitely remote.

These numbers were doubtless intended only as rough approximations of the actual limit. But a more direct examination of the fact inclines me to believe that they can hardly be accepted even in this spirit, and that the method by which they were made must in some way be open to objection.‡

The problem, it seems to me, can be attacked by means of the pseudoscope, and perhaps most conveniently and successfully when in the form shown diagrammatically in the accompanying figures. A box provided with two eye holes (near *L* and *R* in Fig. 1) is

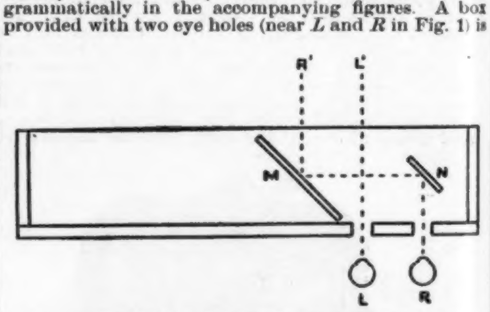


FIG. 1.—NORMAL PSEUDOSCOPIC VISION.

open on the side opposite these holes. In the box are two perpendicular mirrors (*M* and *N*) inclined at a horizontal angle of 45° to the line of sight. Each of these mirrors is rigidly held in a small frame (for simplicity's sake, not indicated in the figure) which can be slipped to the right or left in the box and, if need be, turned slightly so as to vary the inclination of the mirrors. In a well constructed instrument the entire movement of the mirrors would be delicately controlled by thumb screws. The mirror, *M*, faces outward and to the right; the mirror, *N*, inward and to the left.

It is apparent that when the mirrors are in the position shown in Fig. 1, the left eye is in direct view of the scene along the line, *LL′*, while the right eye receives its light along the doubly reflected line, *RR′*, so that its view of the scene is practically from a point to the left of the left eye. The relative points of view of the two eyes are thus interchanged and a vivid pseudoscopic effect results. With a little care in adjustment the distance between *R′* and *L′* can be made equal to the interocular distance, and the difference in parallax for different objects remains the same as in normal vision. But the instrument also permits a wider separation of the lines, *R′* and *L′*, by carrying the larger mirror farther to the left (as in Fig. 2). This arrangement increases

* Les résultats des travaux récent sur la perception visuelle de la profondeur. L'année psychologique, iv, 390.

† Physiologische Optik, 2d ed., pp. 790, 791.

‡ Prof. Le Conte, in putting the limit at "perhaps a quarter of a mile" (Sight, 2d ed., p. 163), comes nearer the mark, although I believe that this, too, is short of the true figure. He does not state the method by which he reached his result.

the parallax, and gives as a consequence a marked accentuation of the pseudoscopic effect. If, again, the smaller mirror on the right be moved so as to come be-

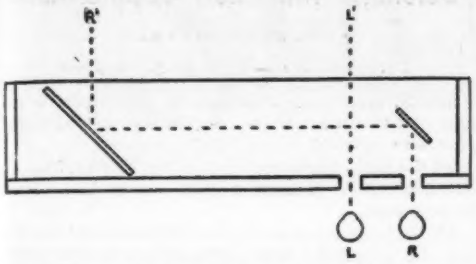


FIG. 2.—EXAGGERATED PSEUDOSCOPIC VISION.

fore the left instead of the right eye (as in Fig. 3), L' and R' are then in the same relative positions as the eyes to which they respectively lead; the pseudoscopic effect consequently disappears, and the instrument becomes what has been termed a "telestereoscope," giving an abnormal relief to objects in the foreground and carrying the stereoscopic effect out into the distance which normally seems "flat."

The advantages of this instrument over the ordinary pseudoscope which makes use of reversed stereoscopic photographs are obvious. In this, as in the Wheatstone pseudoscope, one looks directly at the objects themselves and not at their dull copy. There is, however, no right and left reversal of things, such as the Wheatstone instrument produces, and one can readily get a much larger field of view than ordinary prisms

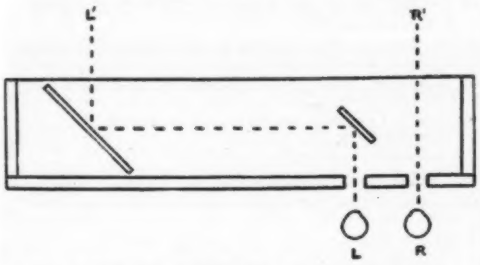


FIG. 3.—EXAGGERATED STEREOSCOPIC VISION.

give. Besides this, an indefinite range of variation of the apparent interocular distance is possible for both pseudoscopic and stereoscopic vision, and consequently an elasticity in experimental use which neither of the other forms permits. For nice experiment with objects very near at hand some correction might be introduced by lens or otherwise, so as to compensate the slight inequality of accommodation in the two eyes, resulting from the greater distance which the light reflected in the mirrors has to travel, compared with the light which comes to the other eye direct.

In applying this contrivance in the present case, the distance between R' and L' was made equal to that between R and L, and in other respects the arrangement was that shown in Fig. 1. The landscape seen under these conditions shows pseudoscopic reversals, but not so often an apparent change of convex into concave objects, and vice versa, as a transposition of the relative distances of objects from the observer. A tree, for example, between the person and a background of other trees may now seem to lie beyond those trees and to be seen through them. There is a distance in the landscape, however, beyond which such transpositions are not noticed, so that the foreground alone shows the pseudoscopic effect, strictly speaking. But where two objects actually suffer such a transposition, one may safely assume that at least the nearer of them is still within the range of binocular perspective. For the transposition is brought about merely by the reversal of the usual binocular differences; and if the objects were so far away as to make their distances binocularly indistinguishable, then the pseudoscope ought to leave them indistinguishable, and no reverse perspective would result. Where the instrument does produce an alteration of perspective it is evident, therefore, that the objects have an effective binocular difference, or, in other words, that at least one of the objects is inside the limit of stereoscopic vision.

But the pseudoscope is effective even beyond the region where actual reversals take place. In this farther zone, though, it gives no pseudoscopic effect in the ordinary sense of the term, but merely saps the stereoscopic life of the scene and leaves it with only the perspective that a skillful painting might have. When the instrument is removed, these more distant objects instantly show a clear stereoscopic relief, which is lost the moment the apparatus is again put before the eyes. The rapid alternation which is thus possible makes one for the first time unmistakably conscious of the presence of real binocular effect. There is, however, a distance at which this perceptible difference between the normal and the pseudoscopic view is lost. Things in this outermost zone look the same—absolutely flat—whether we look at them in the one way or the other. But where there is a rhythmic loss and reappearance of stereoscopic relief, according as the pseudoscope is put to the eyes or taken away, it must be that we are still within the range of true binocular influence. If we were looking quite beyond that range, there could not possibly be the alternation of flat and depth effects which was noticed under these conditions.

The limit beyond which all distances become binocularly indifferent can be roughly approximated in this way. Much more careful series of experiments than I have yet carried out would be necessary, however, before one could speak unguardedly, even as to the mere general position; but I feel certain that the alternation just spoken of is still perceptible in objects 580 meters distant and seen against a varied background of wooded plain several miles away. My own experience has been confirmed by three careful persons—the only ones who were called on—one of these being Prof. Le Conte, who very kindly consented to make the observation. Tests were also made to see whether we were not being tricked into an illusion of stereoscopic perspective by the mere added brightness which the scene showed when both eyes received the light direct, in contrast with the pseudoscopic view where one eye received an image slightly dimmed by the absorption of light in the mirrors. Instead of removing the pseudoscope and looking at the scene in the usual way, an additional set of mirrors was placed in front of the instrument, so that the left eye, too, received a doubly reflected image of the scene, but so that the line of sight, L' in Fig. 1, was carried over the full interocular distance (but no more) to the left of R'. As soon as the lines of sight were thus restored to their normal relation the stereoscopic perspective returned, although in this case the scene was dimmer than the simple pseudoscopic view. If the supposed perspective had been an illusion due merely to the increased light, and not to binocular differences, it would, of course, have failed to appear under these special conditions.

While this more direct method of determining the range of binocular effect seems to me to be important, yet the actual result would after all be but the substitution of a new number for the old, were it not for certain theoretical consequences which the new number implies. The interocular distance in my own case is between 65 and 66 mm., so that in the two retinal impressions of an object distant 580 meters and projected on a background infinitely remote there would be an inequality amounting to less than 24". Yet under very favorable conditions, differences of position less than 50" can no longer be consciously discriminated;* and even under the most favorable conditions—the discrimination of fixed stars†—points have never been distinguished when separated less than 30".

If my present results are at all trustworthy, they would imply, therefore, that the spatial character of the presentation may be perceptibly altered by the presence of differences so minute as to be of themselves entirely inappreciable. The limit of conscious discrimination of angular differences consequently gives no exact basis for computing the limit of conscious binocular effect; on the contrary, this effect may be produced by differences which elude our introspective scrutiny, or which are subconscious, if we wish to use the term in this sense. Those who hold that direct introspective analysis must give the sole and final word as to the constitution of a mental state might, I imagine, still maintain that the stereoscopic aspect of the perception cannot be due to factors which our inner sense is unable to report; that if these elements are indiscernible, it were better to deny that they exist. It would seem to me more reasonable, however, to hold that the causes of this peculiar relief are the same wherever it appears, they being spatial differences in the two visual images, and perhaps, to some extent, differences in the orbital sensations when different parts of these images are superimposed; and that these motives are of themselves directly perceptible when at their best, but in their subtler phases they escape our introspection completely, although still capable of producing an effect which is introspectively apparent. This persistent efficiency, in consciousness, of motives which have become subliminal seems to me the interesting fact which the present experiment illustrates.

We are indebted to The Psychological Review for the above interesting article.

DISTILLED WATER—ITS PREPARATION BY A SIMPLE AUTOMATIC AND INEXPENSIVE APPARATUS, AND ITS PRESERVATION.‡

By H. T. CUMMINGS, M.D.

IN view of the fact that distilled water is an absolute necessity for many pharmaceutical purposes, the writer desires to describe an easily worked, inexpensive and automatic apparatus for producing the substance, and also to consider means for its proper preservation. But first he would consider chemical methods for purifying unsuitable waters and rendering them fit for ordinary purposes when the excessive refinement of distilled water is not necessary.

NATURAL WATERS.

The present edition of the Pharmacopœia defines "aqua" as "natural water in its purest attainable state;" but it goes on to prescribe definite properties which it shall have. It must be a "colorless, limpid liquid, without odor or taste at ordinary temperatures, and remaining odorless while being heated to boiling." And it must be free from metallic impurities, and not possess more than the "limit" of ammonia, soluble salts, sulphates, chlorides, nitrates, and organic or other oxidizable matters, which limits are determined by chemical tests described. If the apothecaries of Maine could turn the Poland or the New Gloucester Shaker Springs into the back rooms of their shops, the pharmacopœial demand would be easily complied with, as these are the sources of the purest water known in Maine, the amount held by them in solution, including organic matter, being somewhat less than four grains to the gallon.

But as springs, wells, rivers, and lakes are generally loaded with substances dissolved or suspended therein, it becomes a problem of no little importance how to purify water taken from these sources with the least trouble and the greatest expedition. "No water in nature is perfectly pure; rain and snow water caught even in perfectly clean vessels contain, especially at the beginning of rain, foreign substances which are present in the atmosphere as dust or vapor. Ammonia, nitrous and nitric acids, chlorine, sulphuric acid, lime, soda, potash, magnesia, and organic matters have been found therein by many observers." And in addition to all this, the natural waters, in percolating through the soil, take up whatever is soluble; besides, where they are exposed to the direct rays of the sun, they develop confervæ, as well as more distinctly phanerogamous species of plants. In cisterns where rain water is collected and stored, remarkable growths of confervæ and other microscopic plants are produced, which do not improve the taste or the odor of the water. The purification of such waters often becomes a serious question, even if it is not desired to obtain them chemically pure.

PURIFICATION BY CHEMICAL MEANS.

The purification of foul waters for pharmaceutical or domestic use, or to render them drinkable, is accomplished in various ways. Sometimes simple filtration through powdered silica, sand, charcoal, paper or other media is sufficient. Water may be perfectly clean and devoid of foreign taste, but yet prove deleterious, or even beget fatal diseases, carrying into the human system the germs of typhoid, cholera, diphtheria, or tuberculosis. In such cases neither filtration nor chemical agents seem to have much power for good. The application of a boiling heat alone proves a protection against infection; and this action is earnestly advised where there is the slightest chance of danger. It had best be done, too, immediately upon drawing the water, for it has been found that bacteria increase remarkably in numbers within a few hours. Miquel found, for instance, that certain water at 60° F. contained in a cubic centimeter 48 bacteria; while three hours later, at 69° F., it contained 125; twenty-four hours later, at 70° F., 38,000; and after seventy-two hours, 590,000, notwithstanding which the water was perfectly clear and appeared as good as the purest potable water.

While there is no reason to fear infection, chemicals may be employed with good effect to fix some volatile bodies and to thrown down others, and thus withdraw them from solution. One formula which is reasonably effective for this purpose is that of Kletzinski, published in the twenty-third volume of the Proceedings of the American Pharmaceutical Association. It is as follows:

Phosphate of aluminum................	1 part
Phosphate of oxide of iron.............	2 parts
Phosphate of magnesium....	2 parts

dissolved in a sufficient quantity of the phosphoric acid of the Austrian Pharmacopœia (16 per cent. strength). The phosphates must be freshly prepared and the solution filtered. When required as a purifying agent, the solution, which will keep any length of time, is added to the water in small quantities, as long as cloudiness is produced; the water is then allowed to stand until the precipitate has subsided, and the clear water may then be used for drinking or other purposes. The action of the phosphatic liquor is explained thus: The lime salts usually contained in water will abstract the phosphoric acid that holds the phosphates of aluminum, iron, and magnesium in solution, and these salts, being deprived of their solvent, will precipitate along with the phosphate of calcium (lime) formed, carrying with them, either mechanically or in chemical combination, such impurities as may exist in the water. The magnesium absorbs all the free ammonia, the iron combines with the sulphureted hydrogen and other gases of decomposition present, while the aluminum and phosphate of calcium will mechanically drag down suspended impurities. The addition of a slight excess of the precipitant is in no way objectionable.

For the removal of mud from water there are two modes of operating. R. F. Fairthorne, of Philadelphia, has found that water can be clarified expeditiously and well by shaking one gallon with one ounce of phosphate of lime, allowing it to settle, and then after two or three days filtering it through absorbent cotton, pressed tightly into the throat of the funnel. The other method is as follows: Filtering paper is soaked in a mixture of 43 parts of liquor ferri chloridi and 57 parts of water, and then dried; a soda paper is made similarly with a saturated solution of sodium bicarbonate. The water is shaken first with a strip of the iron paper, and then with a strip of the soda paper. The carbonate of iron formed absorbs all impurities. The water is then strained through sponge or absorbent cotton.

F. B. Kilmer, of New Brunswick, N. J., has described a method of purifying water fully as simple as that of Fairthorne, mentioned above, and which in the hands of the present writer has proved very effective, namely, the solution of 1¼ ounces Troy of crystallized alum in 32 fluid ounces of water. This solution, used in the proportion of ¾ ounce to half a gallon of foul, ill-smelling, and discolored water from the bottom of a cistern, will render it clear and bright, and fit for general use. If care is used not to employ an excess of the solution, the alum, as Mr. Kilmer says, combining with the organic and mineral impurities of the water, is carried down with them. The resulting water is next to distilled water for purity, and can be obtained in no other way so easily.

Mr. Labor, a pharmacist of Jaligny, has recorded that by collecting, melting, and filtering pure snow he has obtained a supply of "distilled water" perfectly insensible to all the tests for impurity, such as nitrate of silver, perchloride of mercury, soluble salts of baryta, alkaline carbonates, and oxalate of ammonia. Melted ice has repeatedly been recommended for the same purpose, but is looked upon with suspicion or disfavor by both medical men and chemists. It should be observed that pure snow can be obtained with certainty only at the closing portion of a storm, after a heavy fall of snow has swept the atmosphere clear of dust, spores, germs, and animalcules of whatever kind, especially in cities and other places of dense population.

DISTILLED WATER.

The methods detailed above will yield a "natural water" which is sufficiently safe and suitable for ordinary purposes, and which will correspond to the requirements of the Pharmacopœia. But for certain purposes, a water must be had which is absolutely free from all fixed or volatile foreign constituents. Such a water can only be obtained by distilling. Distilled water should be used in the preparation of eye waters and the like; and always, too, in making solutions of "corrosive sublimate, silver nitrate, lead acetate and subacetate, potassium permanganate, iron and zinc sulphates, quinine sulphate, cocaine hydrochlorate, morphine sulphate, hydrochlorate and acetate, and in general terms, all of the alkaloids and their salts,"

* Helmholtz: Physiologische Optik, 2d ed., p. 259.

† Hooke, cited by Helmholtz, ibid., p. 256.

‡ Prize paper in the Bulletin of Pharmacy contest.

If a water be used for these purposes which is not entirely free from salts, new chemical compounds are formed, which means either discoloration, precipitation, or undesirable change. For the same reasons, distilled water should be used in making medicated waters and diluted acids. It is explicitly demanded in seventy-nine formulas of the Pharmacopœia.

The absence of stills or retorts in the majority of ordinary pharmacies is a reason for the general ignoring of the requirements of the Pharmacopœia in this regard. Those who have attempted its preparation when they have had any distilling apparatus have found the labor of attending to the condensation of the steam, the filling of the still, and the care of the furnace, varied, perhaps, by the necessity of attending to wordy customers, or compounding a complicated prescription, sufficient on one trial to discourage them from a repetition. Apothecaries have eyed these formulas with a sort of despair, and in a majority of cases have quietly obtained their distilled water (sic?) from the "moss-covered bucket that hung in the well," or from the pump, or from the faucet at the sink in their back room, while physicians have had to content themselves as best they could with supplies from the same sources, or to fall back on the aromatic waters.

AN INEXPENSIVE AND AUTOMATIC DISTILLING APPARATUS.

Now the writer desires to describe an inexpensive, effective, and automatic distilling apparatus, which can be used with little or no trouble by any pharmacist. Procure a square copper boiler of say two or three gallons capacity. Have a half-inch pipe inserted in the median line two inches below the upper edge. This pipe should be three inches long, and bent downward, even vertically. By a rubber tube join this pipe to the inner tube of a ten-inch Liebig condenser (costing 85 cents). With the other end of the inner tube of the condenser connect either a rubber tube or a crook-necked glass tube, which let protrude into a gallon bottle. Here, then, are still, condenser, and receiver. Now through the jacket of the condenser water at ordinary temperature must be kept running in order to condense the steam which passes through the inner tube. For this purpose set at some height above the condenser a pail of ordinary tap water. With a rubber tube siphon this water to the lower end of the condenser, regulating the flow by a pinch-cock. To catch the water as it emerges from the upper end of the condenser, place a pail beneath the outlet pipe. The condenser (supported by a clamp or otherwise) will have to be inclined at such an angle that the condensing water will run in at the lower end and out at the upper without any difficulty. The copper boiler (the still) may be placed on an ordinary stove, or, better and more convenient, on the oil stove in the back room. This apparatus set up will work automatically, the only attention required being to refill the pail of condensing water, as, at rare intervals, it becomes emptied. Distilled water made so easily, so cheaply, and so effectively, the pharmacist has no excuse for not using it whenever necessary.

The receiver bottle should, of course, first be rendered as chemically clean as possible, and the tube which conducts the distilled water into it should be packed at the mouth of the bottle with absorbent cotton, closely enough to exclude floating dust, germs, etc., but not tight enough to create pressure. The first tenth of the distillate should be thrown away, as it contains carbonic acid, ammonia, and other volatile impurities, and the last tenth of the water should not be distilled, lest it pass over with an empyreumatic taste.

If water be used which is not very desirable, it would be well to purify it by one of the methods outlined above, and by boiling it a few minutes before subjecting it to distillation. In placing the water in the still previous to starting distillation, do not fill it more than two-thirds full, leaving room in plenty for the steam.

PRESERVATION OF DISTILLED WATER.

But once having distilled water, we must use means of preserving it from chemical accretions through dust, etc., and from bacterial contamination.

Upon the preservation of distilled water it will be sufficient to quote the remarks made by Dr. Edward R. Squibb in closing a discussion of the subject at one of the sessions of the American Pharmaceutical Association. Dr. Squibb said: "This is a broad subject, and it seems useless to mention a plan I have adopted lately, and have recommended once or twice to others as an excellent means of preserving distilled water. Let a bottle be made chemically clean and be fitted with a good clean cork or rubber stopper. Pierce this stopper with two holes for glass tubing of good size. Let one piece of tubing pass through the stopper so as to reach the bottom of the bottle and project half an inch above the stopper, and tie this end over with a double fold of clean muslin. Let another piece of tubing be bent at a right angle, and having passed one end just through the stopper, tie the other end over with a double fold of clean muslin. Then fill the bottle entirely full of distilled water which may have had the least practicable air contact, and put the stopper as above described in place. When the water is needed from time to time it is poured out through the short bent tube, while the air which enters to replace it is filtered and passes in through the straight tube. In this way, if the water be free from the spores of confervæ, as it usually is when freshly distilled with care, it will remain free, since only strained air can get access to it. When the bottle is not in actual use, the neck and tubes are nicely protected from dust by means of an inverted beaker, whose lip rests on the shoulder of the bottle. Distilled water carefully made and then kept in this way will be preserved for a considerable time. Since I adopted the plan I have had no trouble whatever from confervæ or from any other annoyances."

A new coast survey vessel, to be named the "Pathfinder," is now building in the Crescent Ship Yards at Elizabeth, N. J. It is being fitted out with all modern appliances and is especially designed for service in Alaskan waters. Its length over all will be 196 feet, the capacity 1,000 tons, and the steaming radius 7,000 miles. It is expected that it will be launched in December and start on the cruise for Alaska next spring.

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TABLE OF CONTENTS.

	PAGE
I. ARCHÆOLOGY.—Message Sticks.—By R. H. MATHEWS.—4 illustrations	19195
II. ARCHITECTURE AND BUILDING.—On the Saline Efflorescence of Bricks.—The means of avoidance.—By Dr. OSCAR GERLACH	19184
III. BOATS.—An Up-to-Date Ice Sloop.—By H. PERCY ASHLEY.—10 illustrations	19186
IV. CHEMISTRY.—Distilled Water.—Its preparation by a simple automatic and inexpensive apparatus, and its preservation.—By H. T. CUMMINGS, M.D.	19197
V. ELECTRICITY.—High Speed Telegraph Transmission by Means of Alternators.—3 illustrations	19196
VI. FINE ARTS.—Glass of the Fifteenth, Sixteenth, and Seventeenth Centuries	19184
VII. MISCELLANEOUS.—The Inventor.—1 illustration	19184
Electrical Notes	19193
Miscellaneous Notes	19193
Selected Formulæ	19193
VIII. MUSIC.—Utility of Music in War	19187
IX. NATURAL HISTORY.—Africa and its Animals.—By R. LYDEKKER	19192
X. NAVAL ENGINEERING.—Early Marine Engineering in the United States.—By CHARLES H. HASWELL	19189
Stability of a Battleship Under Damaged Conditions.—By Prof. C. H. PEABODY	19188
XI. PHYSICAL GEOGRAPHY.—The Eruption of Vesuvius.—1 illustration	19190
XII. PSYCHOLOGY.—A Mirror Pseudoscope and the Limit of Visible Depth.—By Prof. G. M. STRATTON.—3 illustrations	19196
XIII. STEAM ENGINEERING.—Economy Test of a Unique Form of Feed Pump.—By F. MERIAM WHEELER.—6 illustrations	19185
XIV. TRAVEL AND EXPLORATION.—Mr. Henry Savage Landor "In the Forbidden Land."—4 illustrations	19194
Pekin.—2 illustrations	19191

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PAGE

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...... 19195

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GER-
...... 19184

r.—10
...... 19186

mple
.—By
...... 19197

leans
...... 19196

even-
...... 19184

...... 19184
...... 19193
...... 19193
...... 19193

...... 19187

DEK-
...... 19192

the
...... 19189
Prof.
...... 19188

s.—1
...... 19190

t of
...... 19196

form
...... 19185

ndor
...... 19194
...... 19191

65

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